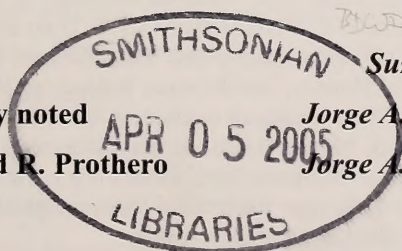


ENTOMOLOGICAL NEWS

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ULTRASTRUCTURE OF THE EGG CHORION OF *NEMOPTERA SINUATA* OLIVIER 1811 (NEUROPTERA: NEMOPTERIDAE) FROM TURKEY¹

Selami Candan,² Zekiye Suludere,² Fatma Açıkgoz,² and Abdullah Hasbenli²

ABSTRACT: The ultrastructure of the egg chorion of *Nemoptera sinuata* Olivier 1811 was studied with scanning (SEM) and transmission (TEM) electron microscopy. Females were collected from Antalya, Finike, Turkey, and maintained under laboratory conditions. Eggs were laid singly in cotton batting. The eggs are spherical, snow-white, and lusterless; with a diameter of 0.82–0.91 mm; and with one micropyle. The chorion is highly sculptured with regular hexagonal convexities on the surface touching one another. The micropyle is in disk form; in profile it resembles a cornet with no opening. In cross section, three layers of chorion are easily distinguished by transmission electron microscopy.

KEY WORDS: Neuroptera, Nemopteridae, *Nemoptera sinuata*, ultrastructure, chorion, micropylar process, scanning and transmission electron microscopy

From recent studies, it appears that the surface structure of various chorionic modifications has morphological, physiological and taxonomic significance in various insect orders (Hinton, 1981; Downey and Allyn, 1984; Salkeld, 1983, 1984; Margaritis, 1985; Gaino et al., 1987; Sahlen, 1996; Lounibos et al., 1997; Suludere et al., 1999; Baker and Chandrapatya, 2001; Wolf and Reid, 2001). Scanning and transmission electron microscopy has become a useful tool for detailed description of surface morphology and ultrastructure in eggs (Mouzaki et al., 1991; Simiczyjew, 1994; Bundy and McPherson, 2000; Danielczok and Kocorek, 2003; Candan and Suludere, 2003; Candan et al. 2004). Hinton (1981) and Margaritis (1985) provide an extensive survey of respiratory and morphological structures of insect eggs. Egg surface structure and ultrastructure of Neuroptera species, including Nemopteridae, has been reported by many authors, however, accurate knowledge of the egg morphology is still lacking for many taxa (Hinton, 1981; Mazzini, 1976; Cutler, 1993; Monserrat, 1985, 1996; Shields and Pupedis, 1997). The ecology and egg of *Nemoptera sinuata* has been briefly described by Popov (2002) using light microscope.

According to Popov (2002) adults of *N. sinuata* occur in meadows and open sunny places with Mediterranean and Sub Mediterranean vegetation near a sheltered river valley and feed only on pollen. They are most active at noon between the middle of May and the end of June. *N. sinuata* is a diurnal insect. It flies, feeds and lays eggs only during the day.

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The eggs are usually laid in the morning, by a female, with half open wings and a drooping abdomen, perched on blossoms or racemes of plants, e.g. *Achillea*. An egg is oviposited every two minutes, and after 4–6 eggs the female moves on to another raceme. Up to 70 eggs are laid by a female over a period of 10 days, during the total female life span of 20 days. Within the first five days the number gradually drops from 14 to 9 eggs per day. The eggs fall directly to the ground or onto dry vegetation. They are not adhesive, but elastic and bounce when coming into contact with a hard surface, as for example a piece of wood. Our study describes the ultrastructure of the egg of the Neuropteran, *N. sinuata* using scanning (SEM) and transmission electron microscopy (TEM).

METHODS

Eggs were obtained from ovipositions by females of *N. sinuata* collected from Antalya, Finike, Turkey (16 June 2001). Females deposited eggs singly onto cotton batting in plastic jars. The eggs were prepared for SEM following the methodology described by Suludere (1988). Cleaned and dried eggs were mounted with double-sided tape on SEM stubs and coated with gold in a Polaron SC 502 Sputter Coater. They were examined with a Jeol JSM 5600 Scanning Electron Microscope at 15–20 kV. Other eggs were fixed with 2.5% glutaraldehyde in a phosphate buffer (pH 7.2) for 2 hours and post fixed with 1% osmium tetroxide in a phosphate buffer (pH 7.2) for 1 hour. The samples were then embedded in Glauert's araldite medium and the ultra thin sections were stained with Reynold's lead citrate following uranyl acetate. These eggs were examined with a Zeiss EM 900 Transmission Electron Microscope at 80 kV.

RESULTS AND DISCUSSION

From our observations; *N. sinuata* deposited eggs singly into cotton batting in the laboratory and egg number varied from 35 to 60 and were not adhesive. *N. sinuata* eggs are spherical, snow-white, opaque, and lusterless. Eggs average 0.82–0.91 mm (Fig. 1, 2). The genus *Nemoptera* is one of the few genera among all Neuroptera with spherical eggs. In the Chrysopidae, Brothidae, and Mantispidae, eggs that are generally cylindrical, e.g. *Mantispa sayi* Banks (Mantispidae) eggs are elongate and cylindrical with rounded ends. Each *N. sinuata* egg has a buttonlike micropylar process at one apex; at the opposite end a short, thin flexible stalk anchors the egg to the substrate by the egg stalk (Shields and Pupedis, 1997). Mazzini (1976) also stated that *Chrysopa carnea* Steph. (Chrysopidae) has a cylindrical egg and the micropylar area of the egg is at the anterior pole, while the posterior pole has a peduncle which functions to attach the egg to the substrate. Monserrat (1996) reported that *Lertha sofiae* Monserrat (Nemopterinae) has an ovoid egg and the micropyle is conical with a discoidal and conspicuous apex. Surface of chorion covered with convex ovarian follicle cell impressions, irregularly hexagonal and bordered by subcylindrical crests. The color of the eggs is yellowish white when laid, rosaceous some days later, and

dark grayish prior to hatching. In addition the eggs of *Nemoptera bipennis* were described by Withycombe (1925) and Monserrat (1985). Eggs of *N. bipennis* are spherical, similar to a golf ball, prolonged in the cephalic apex by a truncated cone formation in whose end it is located micropyle. The chorion has hemispheric swellings more convex in the equatorial zone than in the poles. The cephalic pole has a truncated cone formation that in its base is limited by the hexagonal margins of the peripheral swellings. Micropyle, as a plate, is to circulate, thicker in the external margins. Its surface shows a porous structure, with multitude of internal tubules that give a sponge aspect to it.

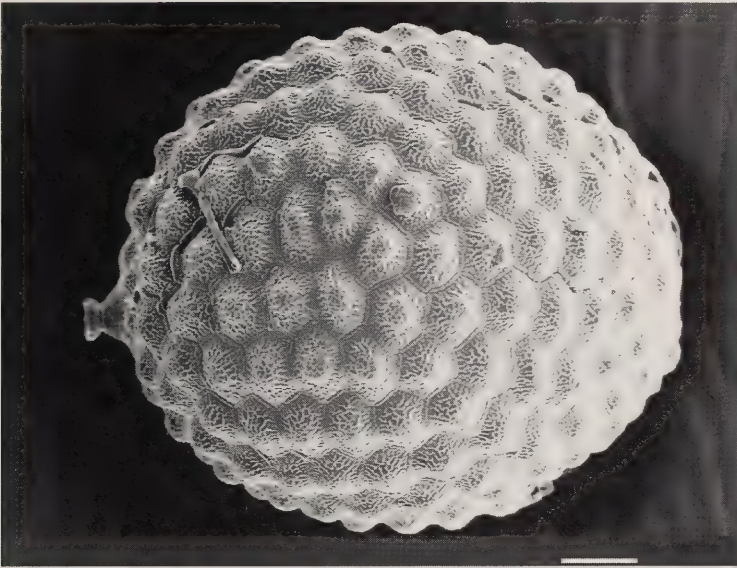


Fig. 1. Scanning electron micrograph (SEM) of *Nemoptera sinuata* egg, lateral view. Scale bar = 100 μ m.

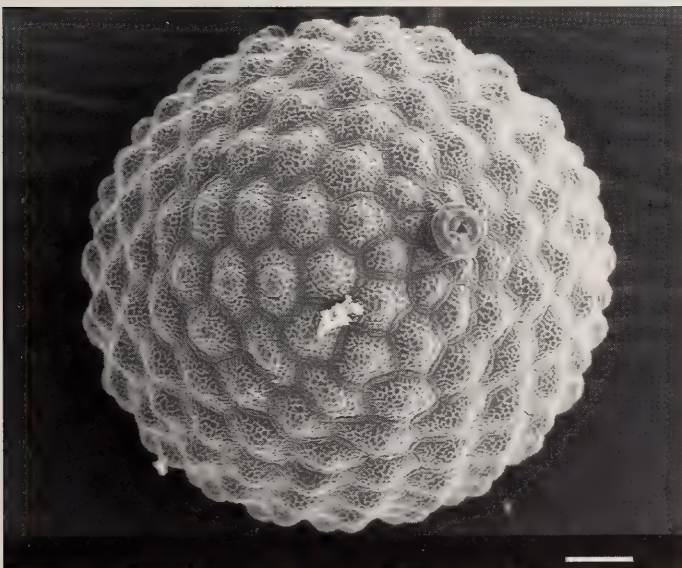


Fig. 2. SEM of egg of *N. sinuata*, end view with micropyle. Scale bar = 100 μ m.

In Neuroptera, including Nemopteridae, and in the Chrysopidae, eggs are laid unconcealed and usually not in an organized arrangement, although occasionally a straight row of 10-15 eggs may be found across a leaf or stem. Some species of *Chrysopa* lay single singly, e.g. *C. rufilabris* Burmesiter and *C. chi* Fitch (Smith, 1922). Each egg has a single stalk, but if the female is confined in a small space, the stalk of one egg may be attached part of the way up the stalk of another egg (Hinton, 1981). However, these three families are not closely related and have presumably independently evolved a stalked egg. The stalks of the eggs of the Mantispidae are only about twice the length of the egg, whereas in many Chrysopidae they may be over 10 times the length of the egg (Hinton, 1981; Shields and Pupedis, 1997). *Nemoptera sinuata* eggs do not have an egg stalk.

In Neuropterans, the micropylar apparatus is usually conspicuous as a plate or knob raised well above the surface. In the Coniopterygidae the micropylar apparatus is on a conical projection at the anterior pole. In the Chrysopidae the knob is somewhat flattened and saucer-shaped. In the Myrmeleontidae and Ascalaphidae, in which the micropyle is also in the form of a shallow saucer, there is a ring of perforations at the margin of saucer and from these perforations the canals pass inwards to an area at the centre. In both Myrmeleontidae and Ascalaphidae there appears to be a similar structure at the posterior pole and it has therefore been suggested that in these two families there are both anterior and posterior micropyles (Withycombe, 1925). Henry (1972) states that in the Ascalaphidae identical micropyles are present on both the anterior and posterior ends. In *Mantispa sayi* eggs, micropylar prominence is roughly dome-shaped and above the surface of the chorion. The basal periphery of the micropylar knob is divided into 8-10 scallops that project downward (Shields and Pupedis, 1997). In *C. carnea* the micropylar region appears circular and the margin of the micropylar area has 30 indentations each of which corresponds to a micropylar orifice (Mazzini, 1976). Also Monserrat (1996) stated that eggs of *L. sofiae* have a conical micropyle with a discoidal and conspicuous apex.

In *N. sinuata*, there is one micropylar process at the anterior pole (Fig. 1-4). When seen from above, the micropyle has the form of a disk; in profile it looks like a cornet with no opening in it (Fig. 3). A polar lid with the micropyle in the center is opened during hatching (Fig. 4). The micropylar process has a central canal for the passage of sperm and has a porous structure which serves for respiratory interchange (Southwood, 1956; Cobben, 1968; Hinton 1981; Lambdin and Lu, 1984; Shuxhi, 1985; Javahery, 1994; Candan, 1997; Candan 1999; Candan and Suludere, 1999 a, b; Suludere et al. 1999; Candan and Suludere, 2003; Candan et al., 2004). Similar observations are presented in this study for *N. sinuata*.

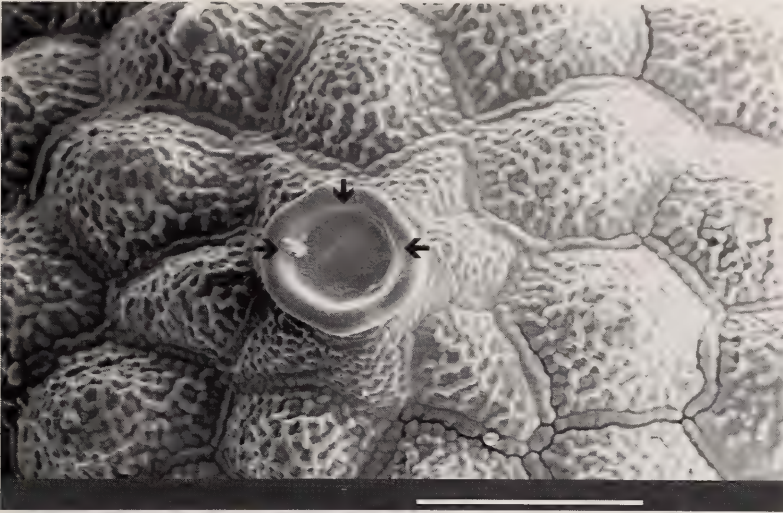


Fig. 3. SEM of a closed micropyle (➡) in unhatched egg of *N. sinuata*. Scale bar = 100 μm .

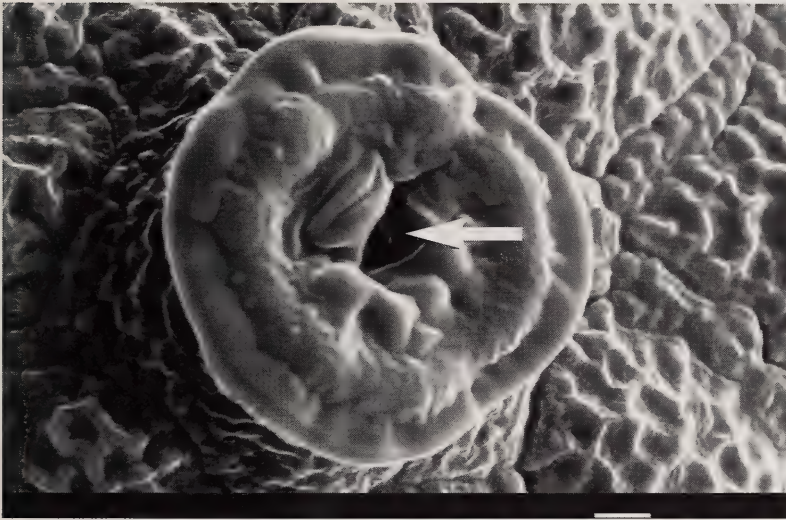


Fig. 4. Micropyle opening (arrow) of a hatched egg of *N. sinuata*. Scale bar = 100 μm .

In the Chrysopidae, Mantispidae, and other Neuroptera in which the surface of the chorion is densely set with projections, a film of air is trapped by these when the eggs are flooded. This is an example of plastron respiration projections as in some dipterous eggs with rather similar projections e.g. *Anopheles* (Culicidae) and some Syrphidae. The projections protect the general surface against the effects of turbulence, and they establish a boundary layer of air creating a humidity gradient that reduces the loss of water (Hinton, 1981).

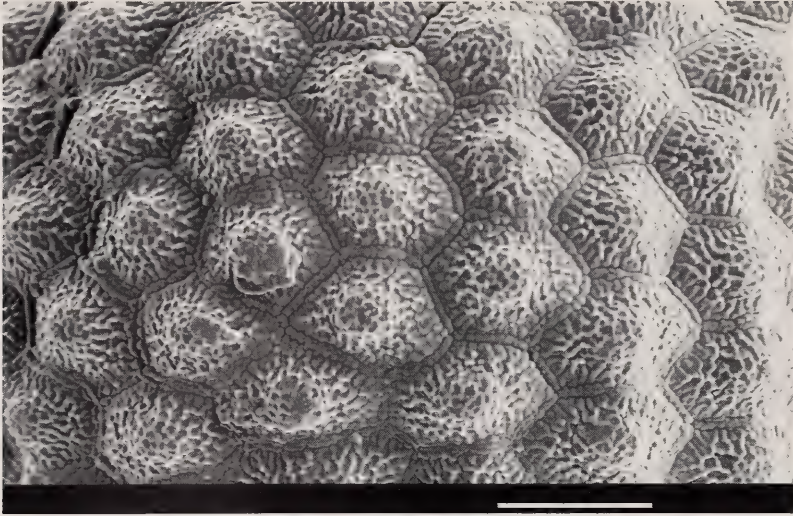


Fig. 5. Hexagonal pattern on the chorion surface of *N. sinuata*. Scale bar = 100 μm

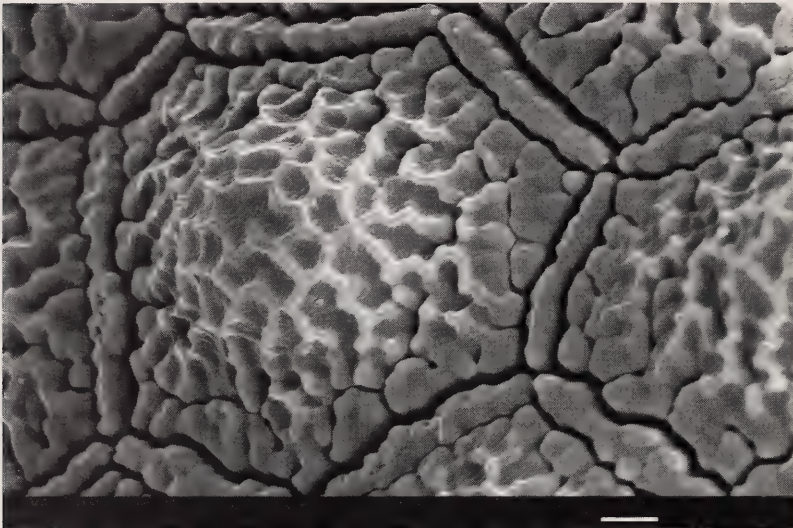


Fig. 6. High magnification of the hexagonal pattern on the chorion surface of *N. sinuata* egg. Scale bar = 10 μm .

The surface of the egg chorion of *Mantispa sayi* Banks appears to be devoid of these features, but closer examination reveals a meshwork of interconnecting ridges on the surface of the chorion and the micropylar surface except at the region of stalk attachment (Shields and Pupedis, 1997). The surface of the egg chorion of *C. carnea* also shows a uniform surface sculpturing at low magnification and near the peduncle the surface appears smooth. At higher magnification the surface sculpturing of the chorion appears as raised, irregular projections joined by narrow bridges (Mazzini 1976). In *L. sofiae* eggs, the surface of the chorion is covered with convex ovarian follicle cell impressions, irregularly hexagonal and bordered by sub-cylindrical crests.

The egg chorion of *N. sinuata* is highly sculptured, with many regular hexagonal convexities on the surface, which touch one another and these hexagonal boundaries are well defined. The surface of the hexagonal boundaries are depressed and rough (Fig. 5, 6). Popov (2002) stated that about 30 convexities have been counted on the periphery of the egg and about 180 convexities on the whole egg surface. According to our observations, *N. sinuata* eggs have similar chorion morphology with *L. sofiae* and *N. bipennis* but *L. sofiae* has different egg shapes. The egg shape in *L. sofiae* is ovoid but in *N. sinuata* and *N. bipennis* it is spherical.

After the 15th or 16th day the egg becomes light pink and then grey on one side. The embryo lies in the form of a semicircle in the egg. A polar lid with the micropyle in the centre is opened during hatching. The lid is cut off by an egg-breaker on the larval clypeus and the eggshell breaks by pressure from the dorsal surface of the larva. The split becomes an almost complete circle and the lid separates without breaking from the egg (Fig. 7). The newly hatched larva is 1.9–2.2 mm long including the jaws. They are dorsally grey, with an oblong, transverse, dark spot on both sides of the median line of every thoracic and abdominal segment. There is a large, almost black, spot on the head and the body is densely covered with long and short setae (Fig. 8). Egg hatching and first instar larvae of *N. sinuata* from Bulgaria (Popov, 2002) and *N. bipennis* Illiger reared by Monserrat (1996) are very similar to those we observed.



Fig. 7. Hatched egg of *N. sinuata*. Scale bar = 100 μ m.

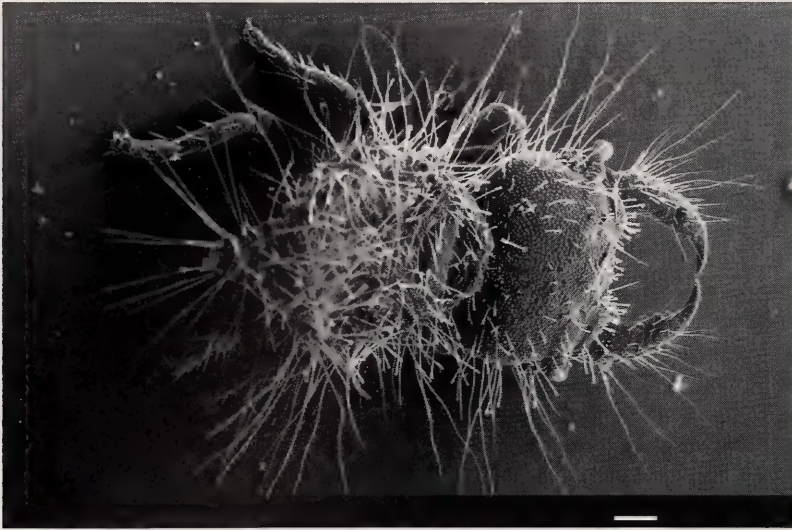


Fig. 8. The first instar larva of *N. sinuata*. Scale bar = 100 μ m.



Fig. 9. Cross section of the egg-chorion of *N. sinuata* (TEM). Endochorion (1), exochorion (2), extrachorion (3) X 10,000.

Examination of a cross section of the chorion shows that it is composed of three layers. The basal endochorion has layers of fibers. Under this there are air cavities of different sizes which are thought to function in plastron respiration. The exochorion appears as a large and homogenous layer. Above the exochorion is the extrachorion, which is composed of electron dense and electron light layers extending to the exochorion layer (Fig. 9). Mazzini (1976) reported that the egg of *C. carnea* has two layers, the endochorion and exochorion. The endo-

chorion consists of plurilaminar layers, each periodically arranged and parallel to the egg surface. The exchorion consists of numerous projections, separated from one another by spaces. Cutler (1993) observed an inner chorion and pillars that formed a continuous air space in *M. interrupta* Say eggs.

Insect eggs require a large surface area in order to supply the oxygen required by the developing embryo. Because of the presence of air spaces as seen in the cross section under TEM, the eggs of *N. sinuata* are able to perform plastron respiration, thus supplying enough oxygen without significant moisture loss. As suggested by Hinton (1969), the chorion is probably so structured so that water loss is kept to a minimum.

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A NEW SPECIES OF *THEVENETIMYIA* BIGOT, 1892 (DIPTERA, BOMBYLIIDAE, ECLIMINAE) FROM TURKEY¹

Abdullah Hasbenli²

ABSTRACT: A new species of *Thevenetimyia* Bigot, 1892 from Turkey is described and illustrated. A key to Palaearctic species of *Thevenetimyia* and drawings of male genitalia of *Thevenetimyia zerrinae* sp. n. are given.

KEY WORDS: Diptera, Bombyliidae, *Thevenetimyia*, new species, Turkey

This study is based on a single specimen collected during field work undertaken by me in southwestern Anatolia (Turkey) during 1999. This specimen is quite distinct from previously collected species of *Thevenetimyia* Bigot, 1892; Hall, 1969; Engel, 1932). There are 37 described species of *Thevenetimyia* worldwide (Evenhuis & Greathead, 1999). Only two species of *Thevenetimyia* have been described from Palaearctic Region (Hall, 1969), apparently both with limited distribution. *Thevenetimyia hirta* (Loew, 1876) is known only from southern Greece and *T. quedenfeldti* (Engel, 1885) from northern Algeria (Hall, 1969).

Thevenetimyia zerrinae sp. n. (Figs. 1-7)

Description: Holotype, length 24 mm, proboscis 8 mm, wing 18 mm. Ground color of head shining black. Orogenal cup shining black. Face, front, 1. and 2. segments of antennae, ocellar tubercle, palpi and ventral of head with black hairs. Occiput evenly swollen with yellowish hairs. Eyes holoptic. Antennae cylindrical, I and II segments reddish yellow, III segment black. Length ratio of antennal segments 30:12:32. Palpi black and as long as head. Proboscis as long as thorax.

Ground of thorax dull black, only femora, tibiae and tarsi of all legs reddish. Coxae with black hairs. Femora I, II with short and black hairs. Femora III, tibia I, II, III and tarsi I, II, III with very short yellowish red spines and hairs. Claws reddish. Scutum and scutellum with black hairs as long as antennal segment II. Above paratergites and two sides of middle line in front half of scutum with numerous thorns. Upper and posterior parts of anepisternum, most of katepisternum and entire metakatepisternum with black hairs. Costa with short and thick thorns from humeral crossvein to the end of the R1 vein. Fore margin of wings reddish yellow. Apices of marginal and submarginal cells from R4+5 fork and 1. posterior cell completely brownish. The veins of wings in anterior half reddish and in posterior half brownish. Anal cell narrowly open. Alulae partly developed. Halteres yellowish-red. Discal, 2. posterior, anal and axillary cells light yellowish. 2. basal, 3. and 4. posterior cells darker.

Abdomen completely shining black. Posterior margin of tergites I-VI covered with golden yellow tufts of hair. Surface of all tergites and sternites with black hairs.

Hypopygium black and with black hairs. Epandrium rectangular. Posterior margin of epandrium with long setae and posterior corners with longer setae. In lateral view, posterior corners of epandrium and sternite VIII very long and strongly setae. Cerci long, wide with a rounded apex. Surface of cerci covered with sparsely microtrichia on the basal and short, densely setae on the apical margins. Basistylus wide, truncate-triangular. Apical and lateral margins of basistylus sclerotized strongly. Dististylus ellipse-like with short and sharp apex. Hypandrium large, triangular. In lateral view, epi-

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phallus wide and the ventral margin of epandrium sinuated. Apex of epiphallus short, narrow, pointed and extended to front. In dorsal view, aedeagus conical with short and narrow apex. Lateral basal plates ellipselike, aedeagal apodeme widened to rounded apex and strongly transparent (Figs 4-7).

Diferential Diagnosis: *Thevenetimyia zerrinae* differs from other congeneric Palaearctic species in length: *T. hirta* and *T. quedenfeldti* are 13-16 mm and 9-10 mm, respectively, whereas *T. zerrinae* is 24 mm long. The oragenal cup of *T. quedenfeldti* is shorter than that of *T. hirta* and *T. zerrinae*. The hairs located on the genae are black in *T. hirta* and *T. zerrinae* but predominantly white in *T. quedenfeldti*. The occiput and the lateral sides of the abdomen of *T. hirta* bear orange or reddish-orange hairs, while *T. zerrinae* and *T. quedenfeldti* has yellow hairs. The entire surface of *T. hirta* wings is brown; the costal margin is dark brown. The wings of *T. quedenfeldti* are brownish, only hind margin near to base of wings lighter. Most of the wings of *T. zerrinae* are yellowish, only apices of marginal and submarginal cells from R4+5 fork and first posterior cell are completely brownish. The legs of *T. quedenfeldti* and *T. hirta* are black; the legs of *T. zerrinae* are reddish and only the coxae are black. The thorns on prescutum are found only on *T. zerrinae*.

The described Palaearctic species of *Thevenetimyia* can be differentiated by examining Table 1.

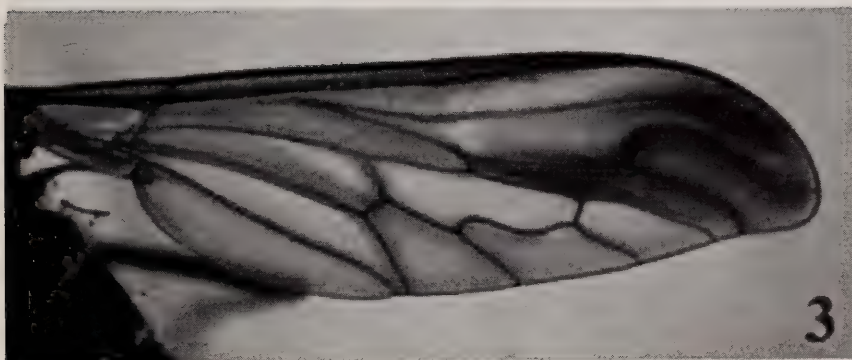
Type Data: Holotype, male collected in Antalya, Kumluca, Salur Village, 100 m, 18.05.1999. The specimen is deposited in the collection of the Zoological Museum of the Gazi University (ZMGU), Ankara, Turkey.

Etymology: The species is named in honor of Zerrin Hasbenli, my wife.

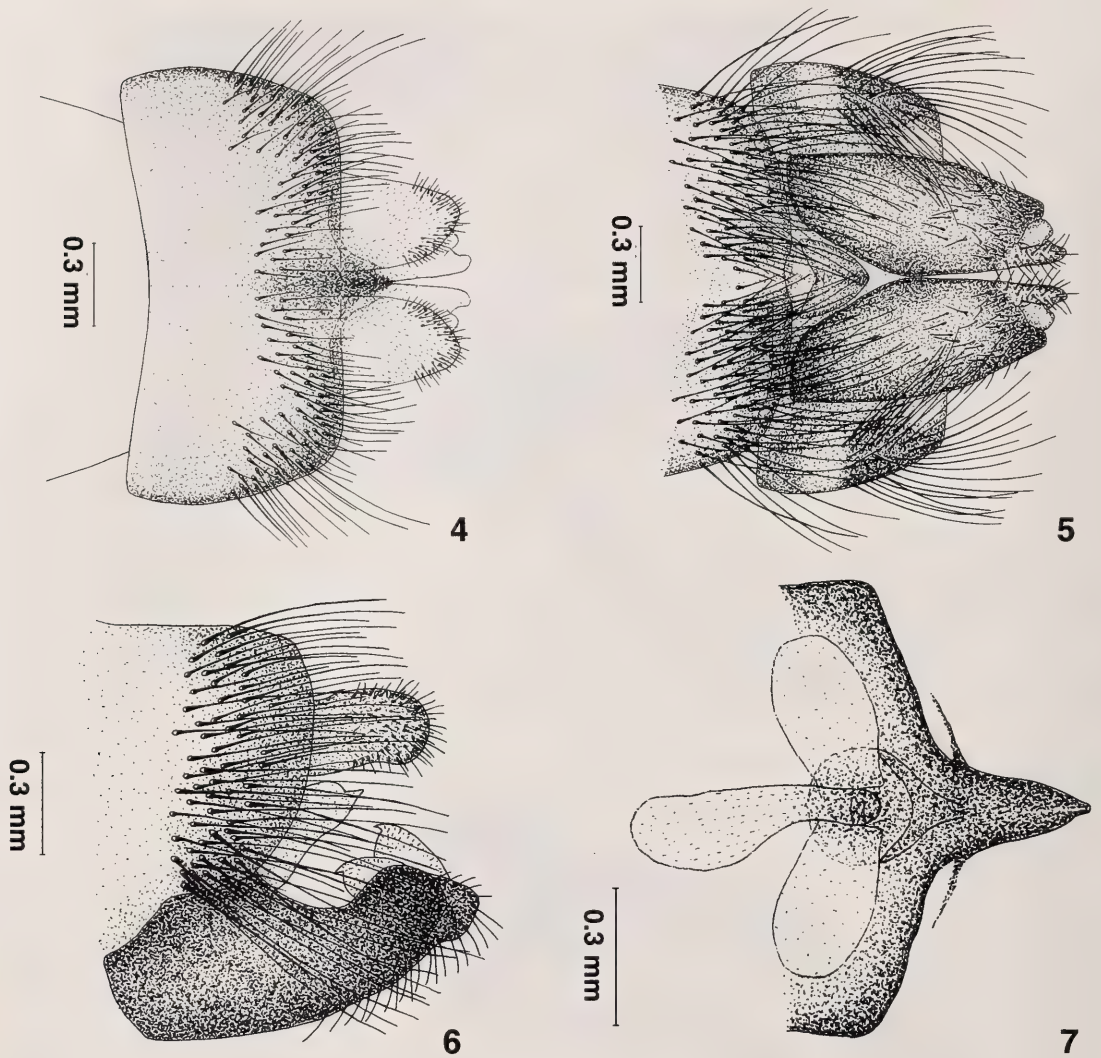
Habitat: The described specimen was collected at 18:00. The collection site is located at the bottom of a valley containing slopes covered with maquis (*Quercus coccifera*, *Genista acanthoclada*, *Spartium junceum*, *Ceratonia siliqua*, *Arbutus andrachne*, *Phillyrea latifolia*, *Cistus creticus*) and sparse pines (*Pinus brutia*). Occasional olive trees (*Olea europea*) are present on the sides of the dry riverbed located in the floor of the valley. The specimen collection site is 1 km to Alakir damlake.

Table 1. Diagnostic characters of Palaearctic species of *Thevenetimyia*.

	<i>T. zerrinae</i> n. sp.	<i>T. hirta</i>	<i>T. quedenfeldti</i>
length (mm)	24	13-16	9-10
oragenal cup	as long as eyes width	2/3 of eye width	2/3 of eye width
genae	black hairs	black hairs	predominantly white
occiput	yellow hairs	orange or reddish-orange hairs	brown hairs
lateral sides of the abdomen	yellow hairs	orange or reddish-orange hairs	golden blonde
legs	reddish	black	black
coxae	black	black	black
thorns on prescutum	present	absent	absent
claws	reddish	dark	black



Figs. 1-3: *Thevenetimyia zerrinae* sp. n. 1. dorsal view; 2. lateral view; 3. wing.



Figs. 4-7: *Thevenetimyia zerrinae* sp. n. 4. Dorsal view of male genitalia. 5. Ventral view of male genitalia. 6. Lateral view of male genitalia. 7. Aedeagus.

ACKNOWLEDGMENTS

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TWO NEW SPECIES *TRISSOPELOPIA* KIEFFER FROM CHINA, WITH EMENDATION OF THE GENERIC DIAGNOSIS AND A KEY TO THE ADULT MALE *TRISSOPELOPIA* OF THE WORLD (DIPTERA: CHIRONOMIDAE: TANYPODINAE)¹

Ming Cheng² and Xinhua Wang²

ABSTRACT: The genus *Trissopelopia* is recorded for the first time from the Oriental region. *Trissopelopia dimorpha* sp. n. and *T. lanceolata* sp. n. are described from male imagines. A key to adult males of the genus of the world is presented. The generic diagnosis is emended.

KEYWORDS: Diptera, Chironomidae, Tanypodinae, *Trissopelopia*, new species, key, China

The Pentaneurini genus *Trissopelopia* was established by Kieffer in 1922. The type species is *T. flavida* Kieffer. The adult males are separated by the following combined characters: scutal tubercle absent; tibial spurs comblike; outer spur of hind leg much smaller than inner spur; tibial comb of leg III absent or indistinct, pulvilli present; tergite IX without a row of setae; palp segment 2 with a distal group of strong dark setae; gonocoxite robust, 2X as long as broad; gonostylus slender, curved, about 2/3 as long as gonocoxite; inferior volsella absent. To date, five species have been recorded in the world: 3 Palearctic (Fittkau 1962, Sasa, Kawai and Ueno 1988, Sasa 1995, 1998), 1 Nearctic (Roback 1971) and 1 Afrotropical (Harrison 1978). According to Wang (2000), only the larva of *T. longimana* (Staeger) has been recorded from North China. In this paper we describe two new species from China and emend the generic diagnosis by Murray and Fittkau (1989).

METHODS

The morphological nomenclature follows Sæther (1980). Wing length was measured from arculus to wing tip. The material examined was mounted on slides following the procedure outlined by Sæther (1969). Measurements are given as ranges followed by the arithmetic mean, when there are three or more measurements, often followed by the number measured (n) in parentheses. LR represents leg ratio, calculated as the length of tarsus 1 / length of tibia 1. All the types described in this paper are deposited in the Department of Biology, Nankai University, China (BDN).

SYSTEMATIC REMARKS

Based on the description of the new species from China, the generic diagnosis of *Trissopelopia* given by Murray and Fittkau (1989) should be emended as

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follows: Wing length 2.23-4.00 mm (2.23 mm in *T. dimorpha* sp. n.). Antennal ratio 0.45-2.50 (0.45-0.77 in *T. dimorpha* sp. n.). Tarsomere 1 on fore leg with (*T. lanceolata* sp.n.) or without large sensilla chaetica. The male antenna with 11, 12 (*T. dimorpha* sp.n.) or 14 flagellomeres.

Previously, the genus was known from the Palaearctic, Nearctic, and Afrotropical regions. The new records from China establish its presence in the Oriental region. There are undescribed species in the Neotropical region.

DESCRIPTION OF TWO NEW SPECIES

Trissopelopia dimorpha sp. n. (Figs. 1-6)

nec *Trissopelopia longimana* (Staeger), Wang 2000: 633.

Type Data: Holotype male (BDN No.12555), CHINA: Sichuan Province, Ya'an City, Zhougong River, 18. VI. 1996, light trap, X. Wang. 2 Paratype: 1 male (BDN No.12580), same as holotype; 1 male (BDN No.10200), Henan Province, Luanchuan County, Longyuwan, 10. VII. 1996, 1000m, light trap, J. Li.

Etymology. Named for the distinctive antenna of the male.

Male imago (n=3)

Dimensions. Total length 3.10-3.28, 3.15 mm. Wing length 2.23-2.58, 2.45 mm. Total length/wing length 1.20-1.39, 1.29. Wing length/ length of profemur 2.06-2.17, 2.10.

Coloration. Head brown. Thorax brown with darker vittae and anterior anepisternum II (Fig. 1); halter yellow. Ground color of abdomen pale yellow, tergites II-VII each with a brown rounded mark in the middle and tergites II-V with additional dark stripe along lateral margins; tergite VIII entirely brown (Fig. 2). Fore legs dark brown, mid and hind legs brown.

Head. Antenna (Fig. 3) with 11 or 12 flagellomeres. The setae of the antennal flagellum are reduced in number. Two specimens (no. 12555 and no. 10200) with 11 flagellomeres (Fig. 3a), the 10th flagellomere is longest, the length of flagellomere (10th) / flagellomere (11th) = 0.34-0.74 (53 μ m / 157 μ m-113 μ m / 157 μ m), AR 0.45-0.46. On the specimen (no.12580) with 12 flagellomeres (Fig. 3b), the 11th flagellomere is longest, the length of flagellomere (11th) / flagellomere (12th) = 2.36 (295 μ m / 125 μ m), AR 0.77. Temporal setae 12-15, 13; including 9-10, 10 verticals and 3-5, 4 postorbitals. Clypeus with 21-26, 23 setae. Tentorium 164-175, 168 μ m long, 49-60, 55 μ m wide. 3rd palpomere with distal tuft of 9-12, 11 strong setae. Palpomere 1-5 lengths (μ m): 62-72, 66; 65-110, 92; 155-180, 170; 215-240, 227; 325-400, 355.

Wings (Fig. 4). Wing thickly covered with numerous macrotrichia and without dark marks. VR 0.78-0.80, 0.79. Costal extension 40-50, 43.3 mm long. Brachiolum with 2-3, 2 long setae. Squama with 21-24, 23 setae. Anal lobe evenly rounded.

Thorax. Anteprenotal setae 3-4, 3. Dorsocentrals 19-24, 22; acrostichals 16-17, 17; prealars 6-7, 7; Scutellars 6-11, 8. Scutal tubercle absent.

Legs. Tibial spurs comblike. Spur on fore tibiae with 3-5, 4 teeth, the main tooth 15-20, 16.7 μm long, equal to the lateral teeth. Middle and hind tibia each with two short and broad terminal spurs. One spur of mid tibia with 6-7, 6 teeth, the main tooth 33-37, 35 μm long, slightly longer than the lateral teeth; the other spur with 8-9, 8 teeth, the main tooth 23-30, 25.3 μm long, equal to the lateral teeth. Spur on posterior tibia with 4-6, 5 teeth, the main tooth 20-25, 23 μm long and slightly longer than the lateral teeth, the other spur s with 7-8, 8 teeth, the main tooth 18-28, 22 μm long equal to the lateral teeth (Fig. 5). Tibial comb indistinct on hind leg. Claw slender, distally pointed and weakly curved Pulvilli present. Length (μm) and proportions of legs (fore tarsi of specimen No. 10200 were lost) as in Table 1.

Table 1. Range of lengths (μm) and proportions of legs of *T. dimorpha* sp. n. Because we got the same measurements, LR in p1 and p3 of *T. dimorpha* sp. n have no variation.

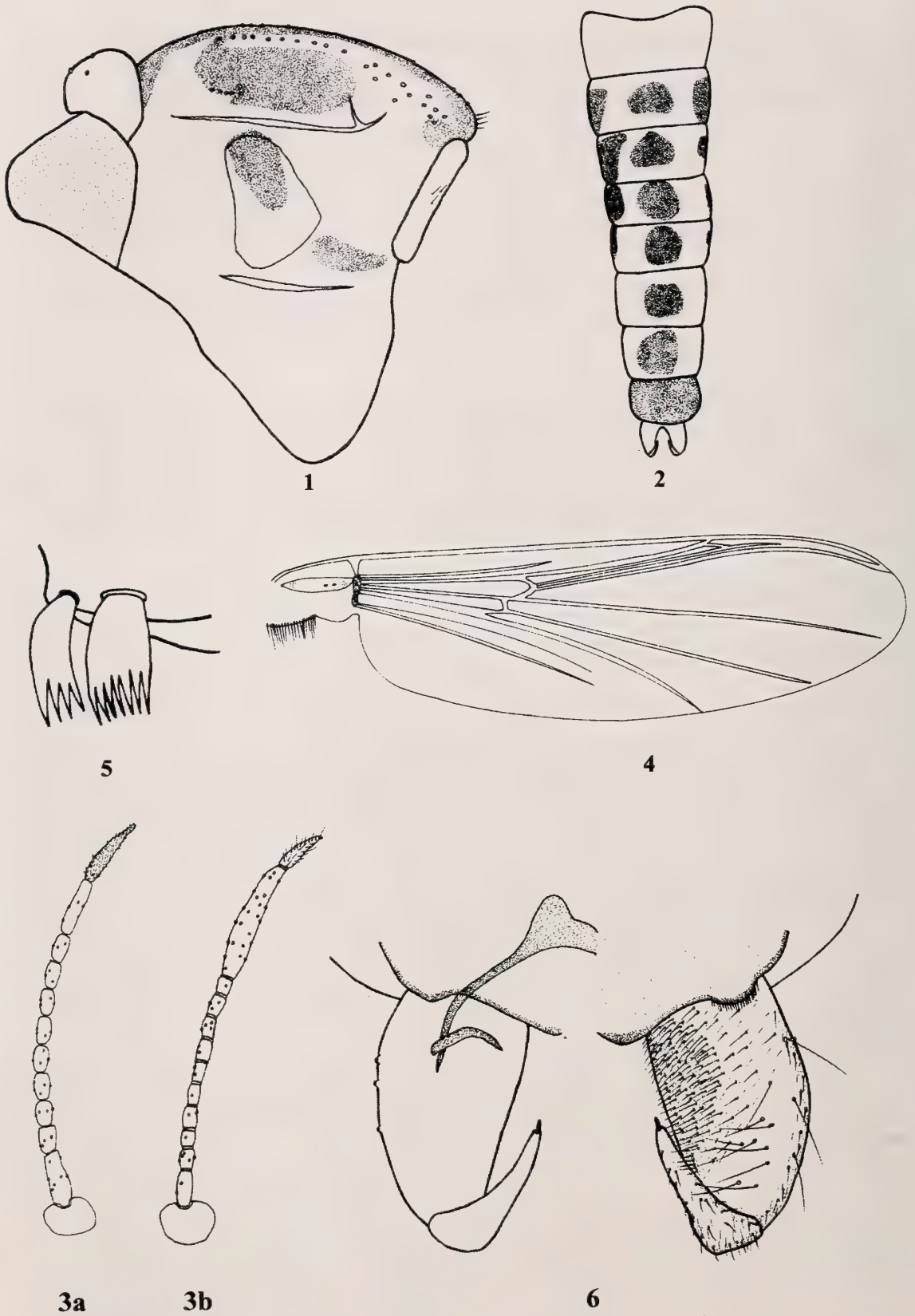
	fe	ti	ta ₁	ta ₂	ta ₃	ta ₄	ta ₅	LR
P ₁	1025-1250 1167	1500-1875 1708	1250-1325	750-82	525-550	340-360	120-130	0.71
P ₂	1100-1325 1242	1450-1625 1558	950-1100 1050	375-475 433	250-350 308	175-225 208	100-125 117	0.66-0.69 .068
P ₃	1000-1200 1125	1650-1875 1750	1175-1325 1242	525-775 692	425-525 492	275-350 310	100-140 125	0.71

Hypopygium (Fig. 6). Tergite IX without a row of setae. Anal point broad and blunt. Phallapodeme 55-72, 65 mm long. Anterior of sternapodeme pointed, 8-10, 9 μm in width. Gonocoxite 145-190, 168 μm long. Length of gonocoxite/width of gonocoxite=1.7-1.9, 1.8. Gonostylus 95-100, 97 mm long, simple and slightly curved, basal portion 35-45, 41 μm wide. Without inferior volsella.

Distribution: The species has been found in both Oriental (southern Sichuan Province) and Palaearctic China (northern Henan Province). The specimen were collected by light trap from the side of Zhougong River, a mesotrophic running river in Sichuan Province and the side of a small brook in a subtropical mountain area in Henan Province.

Remarks: According to Wang (2000), one male was found in Henan Province and treated as *T. longimana* (Staeger). When reexamining the specimen, the authors found it was incorrectly identified. Together with specimens from Sichuan Province we determined them to be a species new to science. The new species differs from all known species of *Trissopelopia* by the characteristic color pattern on the male abdomen (Fig. 2) and femalelike antenna with 11 or 12 flagellomeres, the setae of the antennal flagellum are reduced in number, and low antennal ratio. Although there is variation in the number and shape of flagellomeres, most of the other characters are identical. Therefore, we treat this as individual variation within the species.

Females, pupa, and larva unknown.



Figs. 1-6. *Trissopelopia dimorpha* sp.n. male imago. 1. Thorax. 2. Abdomen. 3a Antenna. (BDN No.12555). 3b Antenna (BDN No.12580). 4. Wing. 5. Tibial spur on hind leg. 6. Hypopygium.

Trissopelopia lanceolata sp. n. (Figs. 7-14)

Type Data: Holotype male (BDN No. 09240), CHINA: Shannxi Province, Ningshan County, Huoditang, 14. VIII. 1994, sweep net, B. Ji. Paratype: 1 male (BDN No. 12571), Sichuan Province, Ya'an City, Zhougong River, 18. VI. 1996, light trap, X. Wang.

Etymology: Named for the lanceolate sensilla chaetica on the fore legs, which is unique to the genus.

Male imago (n=2)

Dimensions. Total length 4.15-4.35 mm. Wing length 2.70-2.73 mm. Total length/wing length 1.54-1.60. Wing length/ length of profemur 2.14-2.20.

Coloration: Head brown. Thorax (Fig. 7) brown with pale vittae and postnotum; anterior anepisternum II and preepisternum with dark marks; halter yellow. Abdomen tergite I pale yellow; tergite II-V pale yellow with broad brown basal bands; tergite VI-VIII largely brown (Fig. 8); hypopygium yellowish. Fore legs dark brown, mid and hind legs brown.

Head. Antenna (Fig. 9) with 14 flagellomeres, flagellomere 13 much longer than flagellomere 14, flagellomere (13th)/flagellomere (14th)=3.25-3.30 (780 μ m /240 μ m -760 μ m /230 μ m), terminal flagellomere with numerous sensory setae on distal half. AR 1.94-2.06. Temporal setae 14-15; including 10 verticals and 5 postorbitals. Clypeus with 22-24 setae. Tentorium 200-212 μ m long, 78-85 μ m wide. 3rd palpomere with distal tuft of 9-12 strong setae. Palpomere 1-5 lengths (mm):55-70; 105-120; 155-190; 215-255; 350-390.

Wings (Fig. 10). Membrane with numerous macrotrichia in all cells and without pigment marks. VR 0.79-0.87. Costal extension 40 mm long. Brachiolum with 2 long setae. Squama with 28-31 setae. Anal lobe slightly protruding.

Thorax Anteprepronotum with 3-5 setae. Dorsocentrals 18-20; acrostichals 19-20; prealars 6-7; Scutellum with 8-11 setae. Scutal tubercle absent

Table 2. Lengths (μ m) and proportions of legs of *T. lanceolata* sp. n.

	fe	ti	ta ₁	ta ₂	ta ₃	ta ₄	ta ₅	LR
P ₁	1225-1275	1900-1975	1150-115	725-75	550-57	400-42	125-12	0.58-0.61
			0	0	5	5	5	
P ₂	1350-1375	1725-1800	1175-120	375-40	325-32	225-22	110-10	0.67-0.68
			0,	0	5	5	0	
P ₃	1250-1300	1925-2225	1425-150	775-85	525-55	325-35	125-12	0.67-0.74
			0	0	0	0	5	

Legs. Tibial spurs comblike. Spur on fore tibia with 4-5 teeth, the main tooth 15-20 μ m long, equal to the lateral teeth. Middle and hind tibia each with two short and broad terminal spurs. One spur on mid with 5-10 teeth, the main tooth

43-45 μm long and slightly longer than the lateral teeth; the other spur with 10 teeth, the main tooth 20-23 μm long, equal to the lateral teeth. Spur on posterior tibia with 5-6 teeth, the main tooth 23-30 μm long and slightly longer than the lateral teeth, the other spur with 7 teeth, the main tooth 20 μm long, equal to the lateral teeth (Fig. 11). Tarsomere I of front legs with six large lanceolate sensilla chaetica (Figs. 12-13). Tibial comb indistinct on hind leg. Claws are pointed apically and weakly curved. Pulvilli present. Lengths (μm) and proportions of legs as in Table 2.

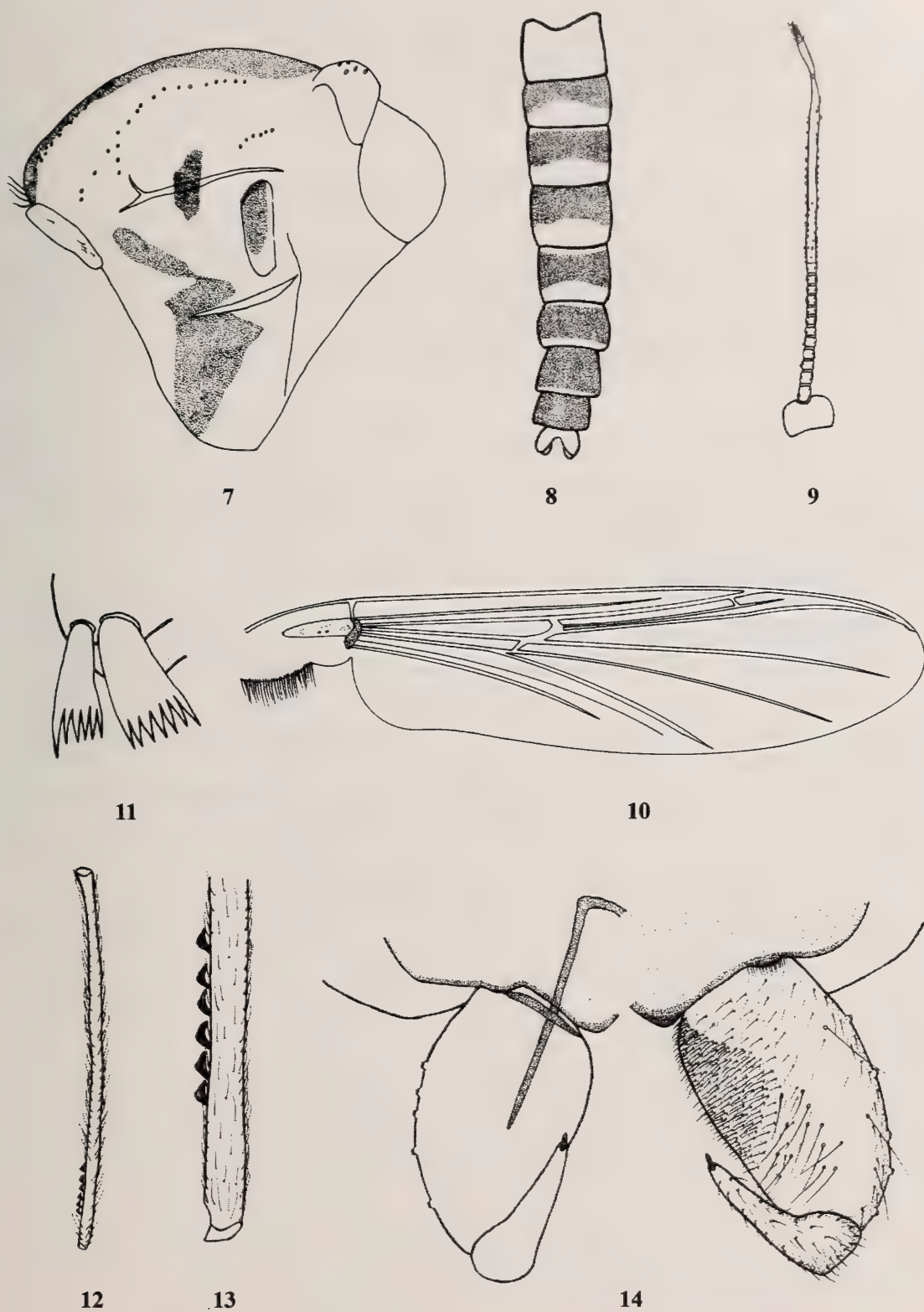
Hypopygium (Fig. 14). Tergite IX without a row of setae. Anal point blunt and short. Phallapodeme 60-63 μm long. Anterior of sternapodeme pointed, 8 μm in width. Gonocoxite 175-180 μm long; length of gonocoxite/width of gonocoxite = 1.71-1.75; with strongly setose basomedial area; without inferior volsella. Gonostylus 110-115 μm long, simple and slightly curved, basal portion 45 μm wide.

Distribution: The specimen were collected from a subtropical mountain area by sweeping net in Shannxi Province and at riverside by light trap in Sichuan Province.

Remarks: The present new species resembles *T. oyabetrispinosa* Sasa, Kawai and Ueno (1988) from Japan and *T. longimana* (Stager) from the Palaearctic as figured by Sasa (1990:165) in abdomen coloration, but can be separated from them and other members in the genus by having 6 large lanceolate sensilla chaetica on tarsomere I of the fore legs.

KEY TO ADULT MALES OF THE GENUS *TRISSOPELOPIA* OF THE WORLD

1. Tarsomere I of fore legs with six large lanceolate sensilla chaetica; Oriental (China) *T. lanceolata* sp. n.
Tarsomere I of fore legs without sensilla chaetica 2
2. Antenna with 11 or 12 flagellomeres, $AR < 1.0$; Palaearctic and Oriental (China) *T. dimorpha* sp. n.
Antenna with 14 flagellomeres, $AR > 1.5$ 3
3. Hind tibia comb with three comb setae; Japan *T. oyabetrispinosa* Sasa
Hind tibia without comb setae 4
4. Middle $Ta_2 < Ta_3$, $LR_1 < LR_2 = LR_3$ (from Roback 1971); Nearctic
..... *T. ogemawi* Roback
Middle $Ta_2 > Ta_3$, $LR_1 = LR_2 < LR_3$ (from Roback 1971) 5
5. Abdomen with TII-VIII and hypopygium mostly dark. $LR_{II} 0.56$; smallest spur on Ti III with 7 lateral teeth (from Harrison 1978); Afrotropical
..... *T. montivaga* Harrison
Abdominal TII-VI/VII with anterior transverse dark bands; hypopygium pale; $LR_{II} 0.62-0.64$; smallest spur on Ti III with 4 lateral teeth; Palearctic 6



Figs 7-14 *Trissopelopia lanceolata* sp.n. male imago: 7. Thorax. 8. Abdomen. 9. Antenna. 10. Wing. 11. Tibial spur on hind leg. 12. Tarsomere I of fore legs. 13. Lanceolate sensilla chaetica. 14. Hypopygium.

6. Wing length 3.6-4.0 mm; deep reddish-brown species (from Fittkau 1962)...
*T. longimana* (Staeger)
 Wing length 3.0-3.4 mm; generally pale yellowish species (from Fittkau
 1962)*T. flavida* Kieffer

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**A NEW SPECIES OF *COMPSORHIPIS* SAUSSURE
(ORTHOPTERA, ACRIDIDAE, OEDIPODINAE),
WITH A KEY TO THE KNOWN SPECIES
FROM CHINA AND ADJACENT AREAS¹**

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ABSTRACT: A new species *Compsorhipis longicornis* of the genus *Compsorhipis* Saussure (Orthoptera, Acrididae Oedipodinae) is described from China. A key to known species of the genus is given.

KEY WORDS: Orthoptera, Acrididae, Oedipodinae, new species, China

The genus *Compsorhipis* Saussure was erected in 1889 (type species *Callirhipis davidiana* Saussure, 1888). The main characters differentiating *Compsorhipis* from closely allied genera, such as *Bryodema* Fieber and *Bryodemella* Yin are the presence of a very wide dark band on the hind wing, main longitudinal veins of hind wing normal and not obviously thickened, hind tibia with many (about 15-17) spines on its inner side, and dense pubescence on the ventral portion of the body and on the legs. Up to now, six species of *Compsorhipis* have been reported worldwide (Saussure, 1888; Bei-Bienko, 1932; Bei-Bienko and Mishchenko, 1963; Chogsomzhav, 1989; Li, et al., 1990; Zheng, 1993; Huo and Zheng, 1993; Zheng and Ma, 1995; Zheng and Xia, 1998; Yin, et al., 1996; Zheng and Gong, 2003), distributed in the southern Transbaikial region of Russia, Mongolia, and northern China. Except for *C. orientalis* Chogsomzhav, 1989, which is distributed only in Mongolia, the remaining five species of *Compsorhipis* are found in China (Fig. 1).

While identifying grasshoppers collected in the Xinjiang Uigur Autonomous Region of China during 2003, a new species of the genus *Compsorhipis* (Oedipodinae) was found and it is herein described. The type specimens are deposited in the Museum of Hebei University (MHU).

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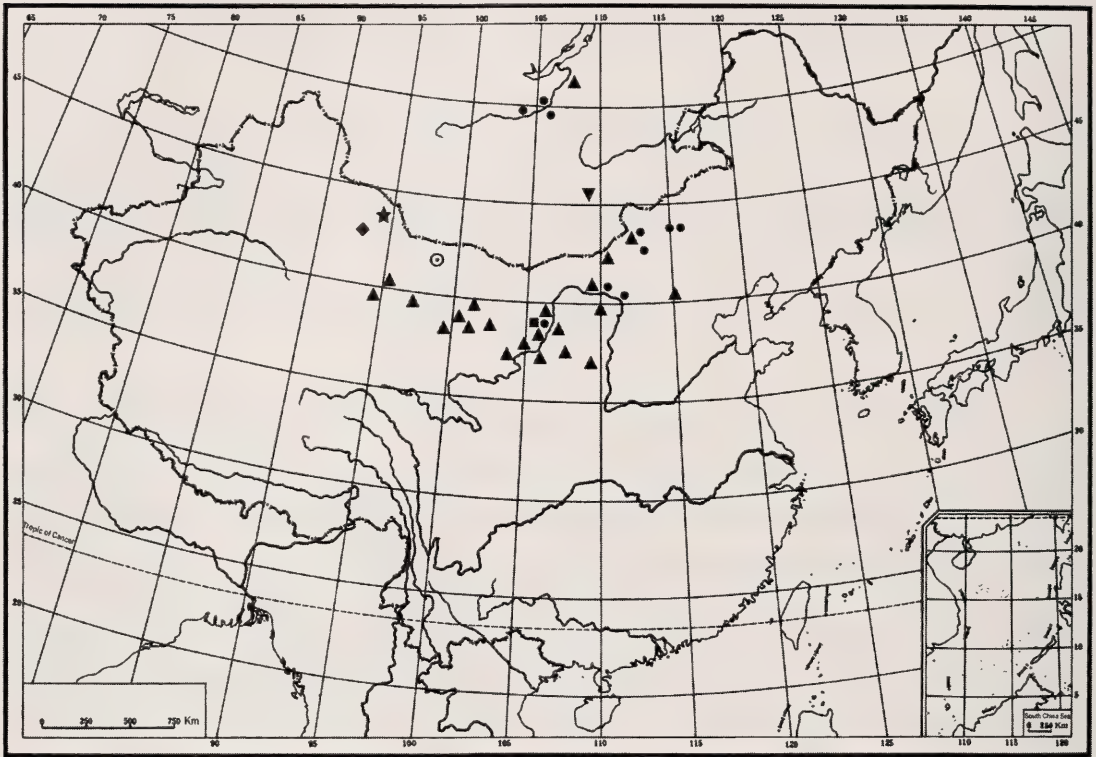


Fig. 1. Distribution of species in the genus *Compsorhipis* Saussure. ■ *C. angustilinearis* Huo and Zheng, ● *C. bryodemoides* Bei-Bienko, ◆ *C. cyanitibia* Zheng et Gong, ▲ *C. davidiana* (Saussure), ★ *C. longicornis* new species, ⊙ *C. nigritiba* Zheng, ▼ *C. orientalis* Chogsomzhav.

Compsorhipis longicornis, NEW SPECIES

(Figs. 2 A-B)

Diagnosis. This new species is similar to *Compsorhipis cyanitibia* Zheng and Gong, 2003. The major differences distinguishing these two species are listed on Table 1.

Type Data. Holotype: male, paratypes: 4 males, 2 females, Yiwu, Xinjiang Uigur Autonomous Region, China (43°12'N, 94°36'E), 1700-2000m, 14 Aug. 2003, collected by Wen-qiang Wang and Xin-jiang Li.

Etymology. The species name is derived from Latin *longi-* (long) and *cornis* (antenna) meaning this new species with longer antennae.

Table 1 Comparison of characters of two species of the genus *Compsorhipis*.

<i>Compsorhipis cyanitibia</i> Zheng and Gong	<i>Compsorhipis longicornis</i> , new species
Length of a middle segment of antennae 1.5-2.0 times its width (male)	Length of a middle segment of antennae 2.4-2.6 times its width (male)
Maximum width of cubital area 1.5 (male) or 2.0 (female) times the width of medial area	Maximum width of cubital area 2.2 (male) or 1.4 (female) times the width of medial area
Basal part of hind wings dark red	Basal part of hind wings purplish red
Width of elytra about equal to maximum width of transparent band of hind wings (female)	Width of elytra 1.4 times larger than maximum width of transparent band of hind wings (female)
Length of hind femur 5.3 times its width (male)	Length of hind femur 4.2-4.5 times its width (male)
Hind tibiae totally dark blue	Hind tibiae blue in terminal part, rest yellowish brown

Description. Male. (Fig. 2-A) Body slender, medium sized, ventrally and legs with dense thin and long hairs. Head short. Frons almost vertical, form obtuse angle with vertex; frontal ridge broad, with longitudinal sulcus obviously, lateral margins slightly narrow below median ocellus, visibly not reaching to clypeus downward. Vertex short and broad, rather flat, its lateral margins distinct. Lateral foveola absent. Antennae filiform, thin and long, the length 1.5 times head and pronotum together, length of a middle segment 2.4-2.6 times its width (Fig. 2-A-1). Eyes oval, longitudinal diameter 1.2 times its horizontal diameter, and 1.1 times subocular sulcus. Interocular distance 1.6-1.7 times width of frontal ridge between antennae. Pronotum contracted in prozona, cylindrical; metazona widened, flat, shoulder shaped outer sides; anterior margin faintly obtuse angular, posterior margin angular projected in the middle; median keel of pronotum thin, absent between transversal sulci; length of metazona 1.8-1.9 times that of prozona; lateral keels absent. Lateral lobe of pronotum rectangular, lateral margins parallel, anterior ventral part right-angular and posterior ventral part rounded. Prosternum appreciably swelled. Width of mesosternal lobes larger than the length, interspace wide, its width larger than that of lobes. Metasternal lobes separated widely. Elytra developed, extending to end of hind tibiae, apices round, length 3.8-4.0 times width; Intercalary vein in medial area slightly curved, relatively closer to median vein rather than to anterior cubital vein; Maximum width of cubital area 2.2 times the width of medial area (Fig. 2-A-3). Hind wings slightly shorter than elytra, main longitudinal veins of hindwings slightly thickened; middle part with a broad and black fascia, its width 1.6-2 times width of elytra. Width of second anal lobe 1.5-1.8 times width of third anal lobe, $2A_1$ vein thicker, $2A_2$ vein thinner and paralleled with $2A_1$ vein. Length of hind femur 4.2-4.5 times its width, median keel of upper side smooth (Fig. 2-A-2). Apex of lower kneelobes angled. Outer side of hind tibia with 12-13 spines, inner side with 14-15 spines, outer apical spine absent. Arolium between claws small, not reach to the half of claws. Tympanum organ developed, aperture approximately rounded; Tympanic flap small, covered less than 1/3 of tympanal aperture. Anal plate triangular, with transversal ridge in the middle. Cerci long cone-shaped, extending to the apex of epiproct. Subgenital plate brevi-conic, apex blunt.

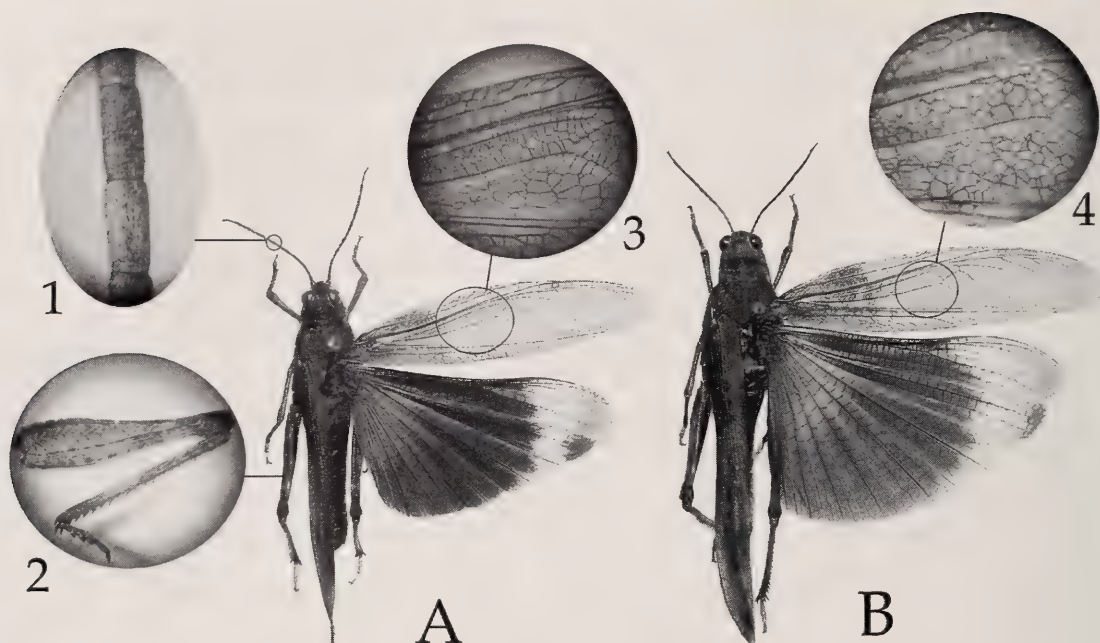


Fig. 2. Photographs of *Compsorhipis longicornis*, new species. A. Dorsal view of male. B. Dorsal view of female. 1. Partial enlarged image of the antenna; 2. Lateral view of the hind leg; 3. Partial enlarged image of the elytron; 4. Partial enlarged image of the elytron.

Female (Fig. 2-B). Body more sturdy than male. Length of a middle segment of antennae 2.3 times width. Length of elytra 4.2 times width, maximum width of cubital area 1.4 times width of medial area (Fig. 2-B-4). Width of second anal lobe of hind wings 1.6 times width of third anal lobe; Width of black fascia of hind wings larger than 2 times of width of elytra. Length of hind femur 3.8 times its width. Ovipositor short and thick, without blunt teeth. Length of subgenital plate larger than width, posterior margin slightly projected in the middle. Others same as male.

Coloration. Body fuscous. Antennae yellow and brown alternated. Basal quarter of elytra dark brown, rest part semitransparent and scatter with some dark speckles mainly in anterior and posterior margins. Hind wings purplish red in basal part, transversal vein within it black; near apical part with a wide transparent band, extending backward to the fourth anal lobe; apical part with two black speckles; Width of elytra 1.4 times larger than the maximum width of transparent band of hind wings (Fig. 2). Hind femur with two indistinctly darker fascia in outer side and with a yellow ring near knees, inner and lower sides black; knees black. Hind tibiae blue in terminal part, the others yellowish brown (Fig. 2-A-2). Tarsi yellow.

Measurements. (mm). length of body: male 29.6-30.0, female 36.0-48.0; length of pronotum: male 6.1-6.3, female 7.3-8.4; length of elytra: male 30.0-31.3, female 35.5-39.8; length of hind femur: male 12.3-13.1, female 15.2-16.7.

KEY TO KNOWN SPECIES OF *COMPSORHIPIS* SAUSSURE

1. Tegmina with regular cross veins in costal area, especially in male 2
 - Tegmina with irregular cross veins in costal area, even in male 3
2. Antennae relatively thick and short, length of a middle segment 3 times (not over 3 times) its width. Hind tibia red
 -*Compsorhipis orientalis* Chogsomzhav, 1989
 - Antennae relatively thin and long, length of a middle segment 4-5 times its width. Hind tibia pale yellow or slightly luteous.....
 -*Compsorhipis bryodemoides* Bei-Bienko, 1932
3. Male's hind tibia black, with a white ring near the basal part. In female, the basal and middle part of hind tibia black, apical and near the basal part white
 -*Compsorhipis nigriritibia* Zheng et Ma, 1995
 - Male's hind tibia not black, without a white ring near the basal part 4
4. Hind tibia orange red, with a dark speckle in the middle part 5
 - Hind tibia wholly blue or blue in terminal part, without a dark speckle in the middle part.....6
5. Transparent band of hind wing wider, the width slightly narrower than that of elytron. Basal part of hind wing rose red in larger scope, width of second anal lobe of hind wing not longer than that of 1.5 times of third anal lobe. Hind tibia orange red
 -*Compsorhipis davidiana* (Saussure, 1888)
 - Transparent band of hind wing narrower, width of elytron larger than that of transparent band of hind wing about 2.6-3.25 times (male) or 2.25 times (female). Basal part of hind wing dark red in smaller scope, width of the second anal lobe of hind wing 1.5 times larger than that of the third anal lobe. Hind tibia yellowish with slightly red
 -*Compsorhipis angustilinearis* Huo et Zheng, 1993
6. Antennae shorter, length of a middle segment is smaller than 2 times of its width. Width of elytron about equal to the maximum width of transparent band of hind wing in female. Maximum width of cubital area 1.5 (male) or 2.0 (female) times the width of medial area. Basal part of hind wing dark red. Length of hind femur 5.3 times its width in male. Hind tibia wholly dark blue
 -*Compsorhipis cyanitibia* Zheng et Gong, 2003
 - Antennae longer, length of a middle segment larger than 2.4 times of its width. Width of elytron larger than 1.4 times of the maximum width of transparent band in hind wing of female. Maximum width of cubital area 2.2 (male) or 1.4 (female) times the width of medial area. Basal part of hind wing purplish red. Length of hind femur 4.2-4.5 times its width in male. Hind tibia blue in terminal part, others yellowish brown.....
 -*Compsorhipis longicornis*, new species

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AN UPDATED LIST OF THE STONEFLIES (PLECOPTERA) OF NEW MEXICO, U.S.A.¹

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ABSTRACT: An updated checklist is presented for the 72 species now known to occur in New Mexico, U.S.A. Distributional data are given for 13 species of stoneflies which are reported from New Mexico for the first time.

KEY WORDS: Plecoptera, stoneflies, New Mexico, U.S.A., new records

In a checklist of intermountain stoneflies, Gaufin (1964) acknowledged 29 species as occurring in New Mexico. With the addition of new species and new state records, the list grew to 42 species (Stewart et al., 1974). Stark et al. (1975) reported 46 species citing current distribution records for eight new state records and others mentioned by Stewart et al. (1974), while in a later systematic, geographic and taxonomic treatment, Baumann et al. (1977) recognized only 44 species. Stark et al. (1986) and Stewart and Stark (2002) have since reported 54 and 58 species, respectively, from New Mexico. Websites (Kondratieff and Baumann, 2000 and Stark, 2001) listed state or county records for 59 species each.

The objective of this report was to synthesize previous lists, unpublished records, recent descriptions of new species and additional distributional and ecological data (Jacobi and Baumann, 1983; Baumann and Jacobi, 1984, 2002; Jacobi and Cary, 1986, 1996; Stanger and Baumann, 1993; Garn and Jacobi, 1996; Jacobi and Jacobi, 1998; Jacobi et al., 1998; and Zamora, 2002).

STUDY AREA

New Mexico is the fifth largest state in the U.S., and one of the most physiographically diverse. The topography and hydrologic regimes provide a variety of flowing water for Plecoptera, ranging in size from major rivers to small temporary or permanent streams. Land surface elevations range from ca. 1050m in the southeast to ca. 4550m in north central New Mexico at the southern terminus of the Rocky Mountains. For a detailed description of the topography and hydrology see McCafferty et al. (1997).

RESULTS

We herein list and report unpublished collection records for 13 species new to New Mexico. The most recent addition to the New Mexico list is a recently described new species *Capnia caryi* (Baumann and Jacobi, 2002) found in the

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headwaters of the Gila River in southwestern New Mexico. We have listed *Acroneuria abnormis* (Newman) as new because the complete collection record was lacking when it was first mentioned as occurring in New Mexico (Baumann and Jacobi, 1984). Additional collection records of this species are also provided.

Our list includes *Isoperla jewetti* Szczytko and Stewart (1979). Nymphs were collected from one of the few remaining cobble substrata in the Rio Grande upstream of Radium Springs in southern New Mexico in 1978 and 1980. Since then numerous searches have failed to produce nymphs or adults in this highly regulated river downstream from concentrated agriculture in the Hatch Valley. The type specimens, collected by J. A. and H. H. Ross in 1939, were from a locality approximately 80 km downstream near El Paso, Texas. This population may have been extirpated due to heavy use of pesticides (Szczytko and Stewart, 1979), but more survey work is needed.

Our list does not include *Neoperla clymene* (Newman). A 1966 collection of this species listed in Stark et al. (1975) and Baumann et al. (1977) was recorded as "Santa Fe Co: 12 miles east of Santa Fe." The specimen, at Brigham Young University, was subsequently identified by B. P. Stark in 1990 as being *Neoperla robisoni* Poulton and Stewart (1991), which had been found in Arkansas. We do not include this species because the collection location is vague and there have been no subsequent reports, despite much collecting in the mountains east of Santa Fe. Also, see the discussion in DeWalt et al. (2002) regarding the validity of this New Mexico record.

The following are the 13 new state records with collection information:

Amphinemura banksi Baumann and Gaufin. – COLFAX Co., Soda Pocket Creek, Sugarite Canyon State Park, 2350 m, 23 VI 2001, S. J. Cary, 3 females. LOS ALAMOS Co., Canyon de Valle, near Burning Ground Spring, 2256 m, 31 VIII 1995, R. Ford-Schmid, 1 female. MORA Co., Manueles Creek, at county line culvert, 2835 m, 22 VIII 1980, G. Z. Jacobi, 5 males, 4 females. SAN MIGUEL Co., Johns Creek, Mosimann Ranch (Lovelady Trust), Sangre de Cristo Mountains, 3 VIII 1963, G. E. and K. E. Ball, 1 male.

Malenka californica (Claassen). – SANDOVAL Co., Jemez River, prob. at Battleship Rock Park, 2050 m, 25 X 1975, B. A. Bowman, 1 male.

Zapada oregonensis (Claassen). – SANTA FE Co., N. Fork Big Tesuque Creek, at Big Tesuque Campground, 23 V 1991, 2940 m, C. R. Nelson, 1 male, 4 females. TAOS Co., East Fork of the Red River, at boundary of Wheeler Peak Wilderness, 9 VI 1974, 3399 m, B. P. Stark and T. A. Wolff, 3 males, 4 females.

Bolshecapnia milami (Nebeker and Gaufin). – TAOS Co., Rio Hondo, above Twining STP, 2850 m, 26 III 1988, G. Z. Jacobi, 1 male.

Capnia uintahi Gaufin. – CATRON Co., Little Turkey Creek, forest trail 151, 2425 m, 22 II 1999, G. Z. Jacobi and S. J. Cary, 8 males, 2 females; Gilita Creek, upstream from Willow Creek, 2400 m, 22 II 1999, G. Z. Jacobi and S. J. Cary, 6 males, 2 females.

Isocapnia crinita (Needham and Claassen). – COLFAX Co., Vermejo River, 23 IV 1986, R. W. Baumann and B. C. Kondratieff, 3 males, 7 females; Vermejo River, 2220 m; same location, 17 IV 1999, G. Z. Jacobi and S. J. Cary, 2 females.

Paraleuctra jewetti Nebeker and Gaufin. – SANTA FE Co., N. Fork Big Tesuque Creek, at Big Tesuque Campground, 21 V 1991, 2940 m, C. R. Nelson, 1 male, 1 female.

Isogenoides colubrinus (Hagen). – SAN JUAN Co., Animas River at Aztec, Highway 550 Crossing at 20th Street, 1630 m, 11 V 2002, S. J. Cary, 1 female.

Isoperla jewetti Szczytko and Stewart. – DOÑA ANA Co., Rio Grande upstream from Radium Springs, 1210 m, 11 II 1978, J. Anderson, 1 nymph; same location, 11 IV 1980, G. Z. Jacobi, 5 nymphs.

Perlesta decipiens (Walsh). – SOCORRO Co., Rio Grande, access road off Hwy 1 at Bosque del Apache National Wildlife Refuge, 2 VII 1995, B. Kondratieff, 2 males, 3 females.

Acroneuria abnormis (Newman). – GUADALUPE Co., Pecos River at Tecolotito, 1615 m, 31 III 1979, G. Z. Jacobi, 1 nymph. SAN MIGUEL Co., Pecos River at Highway 63 bridge above the village of Pecos, 2110 m, 7 IV 1980, G. Z. Jacobi, 1 female; Pecos River at Terrero Store, 2340 m, 22 V 1988, G. Z. Jacobi, 1 nymph; Pecos River upstream from I-25 bridge, 1880 m, 9 IX 1997, D. L. Zamora, 1 nymph. TAOS Co., Rio Grande at Chiflo Campground and USGS Gage, 6 XI 1979, G. Z. Jacobi, 1 nymph.

Alloperla pilosa Needham and Claassen. – LINCOLN Co., Sierra Blanca Creek (N. Fork tributary to N. Fork Rio Ruidoso), 3020 m, 11 VIII 1993, G. Z. Jacobi and M. W. Sanderson, 2 males, 1 female; S. F. Rio Bonito, 2590 m, 10 VI 2002, S. J. Cary 2 males, 2 females; North Fork Rio Ruidoso, Ski Apache, 15 VIII 2001, S. M. Clark, 2 males. The New Mexico specimens do not have a dorsal abdominal stripe like the Colorado specimens, but SEM studies of the male epiproct show that they belong to the same species.

Suwallia starki Alexander and Stewart. – LINCOLN Co., North Fork Rio Ruidoso, Ski Apache, 15 VIII 2001, S. M. Clark, 52 males, 24 females. SAN MIGUEL Co., Dalton Creek upstream from the junction with the Pecos River, 2206 m, 8 VI 1997, D. L. Zamora, 1 female. TAOS Co., Policarpio Canyon, (T22N, R13E, Sec. 16), 13 IX 1965, R. G. Jones, 2775 m, 3 females.

The following is our updated checklist of Plecoptera found in New Mexico; new state records are marked with.*

Family Nemouridae

* <i>Amphinemura banksi</i> Baumann and Gaufin	<i>Prostoia besametsa</i> (Ricker)
<i>A. mogollonica</i> Baumann and Gaufin	<i>Zapada cinctipes</i> (Banks)
* <i>Malenka californica</i> (Claassen)	<i>Z. frigida</i> (Claassen)
<i>M. coloradensis</i> (Banks)	<i>Z. haysi</i> (Ricker)
<i>M. flexura</i> (Claassen)	* <i>Z. oregonensis</i> (Claassen)
<i>Podmosta delicatula</i> (Claassen)	

Family Taeniopterygidae

<i>Doddsia occidentalis</i> (Needham and Claassen)	<i>T. pallidum</i> (Banks)
<i>Taenionema jacobii</i> Stanger and Baumann	<i>Taeniopteryx parvula</i> Banks
<i>T. pacificum</i> (Banks)	

Family Capniidae

* <i>Bolshecapnia milami</i> (Nebeker and Gaufin)	<i>C. wanica</i> Frison
<i>Capnia californica</i> (Claassen)	<i>Eucapnopsis brevicauda</i> (Claassen)
<i>C. caryi</i> Baumann and Jacobi	* <i>Isocapnia crinita</i> (Needham and Claassen)
<i>C. coloradensis</i> Claassen	<i>I. vedderensis</i> (Ricker)
<i>C. confusa</i> Claassen	<i>Mesocapnia arizonensis</i> (Baumann and Gaufin)
<i>C. decepta</i> (Banks)	<i>M. frisoni</i> (Baumann and Gaufin)
<i>C. gracilaria</i> Claassen	<i>M. werneri</i> (Baumann and Gaufin)
* <i>C. uintahi</i> Gaufin	<i>Utacapnia logana</i> (Nebeker and Gaufin)
<i>C. vernalis</i> Newport	<i>U. poda</i> (Nebeker and Gaufin)
<i>Capnura fibula</i> Claassen	

Family Leuctridae

**Paraleuctra jewetti* Nebeker and Gaufin*P. vershina* Gaufin and Ricker*P. occidentalis* (Banks)*Perlomyia utahensis* Needham and Claassen*P. projecta* (Frison)

Family Pteronarcyidae

Pteronarcella badia (Hagen)*Pteronarcys californica* Newport

Family Perlodidae

Cultus aestivalis (Needham and Claassen)*I. mormona* Banks*Diura knowltoni* (Frison)*I. phalerata* (Smith)**Isogenoides colubrinus* (Hagen)*I. quinquepunctata* (Banks)*I. elongatus* (Hagen)*I. sobria* (Hagen)*I. zionensis* (Hanson)*Kogotus modestus* (Banks)*Isoperla fulva* Claassen*Megarcys signata* (Hagen)**I. jewetti* Szczytko and Stewart*Skwala americana* (Klapalek)*I. longiseta* Banks

Family Perlidae

Acroneuria abnormis* (Newman)*Hesperoperla pacifica* (Banks)*Claassenia sabulosa* (Banks)Perlesta decipiens* (Walsh)

Family Chloroperlidae

Alloperla pilosa* Needham and Claassen*S. coloradensis* (Banks)*Paraperla frontalis* (Banks)*S. hondo* Baumann and Jacobi*Plumiperla diversa* (Frison)*S. lamba* (Needham and Claassen)*Suwallia pallidula* (Banks)*Triznaka pintada* (Ricker)S. starki* Alexander and Stewart*T. signata* (Banks)*Sweltsa borealis* (Banks)

DISCUSSION

In the 40 years since Gaufin's (1964) initial report, 43 species have been added to the New Mexico list, including three new species, *Sweltsa hondo* Baumann and Jacobi, *Taenionema jacobii* Stanger and Baumann, and *Capnia caryi* Baumann and Jacobi. The updated total is now 72 species. The family Capniidae is best represented in the state, comprising 26 percent of the known species. This may, in part, be due to encouragement to collect by members of the winter stonefly club (Nelson and Baumann, 1989) and our interest in zoogeographical distributions and seasonal habitats of Plecoptera (Jacobi and Cary, 1986, 1996).

Only one species with a western affinity, *Mesocapnia frisoni* (Baumann and Gaufin), has been found east of New Mexico (Texas) while three species with eastern origins, *Acroneuria abnormis* (Newman), *Perlesta decipiens* (Walsh), and *Taeniopteryx parvula* Banks, have been found in New Mexico. To date, the nearctic family Peltoperlidae has not been collected in New Mexico. The sur-

rounding states and Mexico have the following numbers of species: Arizona (23), Utah (81), Colorado (86), Oklahoma (57), Texas (25), and Mexico (38) (Call and Baumann, 2002; Kondratieff and Baumann, 2000, 2002; Sargent, 1991; Stark and Kondratieff, 2004; and Stewart and Stark, 2002). The number of stoneflies in New Mexico is neither high nor low compared to surrounding areas; lower counts elsewhere are perhaps due to less diverse habitats or reduced efforts in collecting.

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PARAFUSCOPTILIA: A NEW GENUS OF PLUME MOTHS (LEPIDOPTERA: PTEROPHORIDAE) FROM CHINA¹

Shu-Lian Hao² and Hou-Hun Li^{2,3}

ABSTRACT: A new genus, *Parafuscoptilia* gen. nov. in the Pterophoridae is established. The type species, *Parafuscoptilia tubuliformis* sp. nov., is described based on specimens collected in Fujian, China. The adult as well as male and female genitalia are illustrated.

KEY WORDS: Lepidoptera, Pterophoridae, *Parafuscoptilia*, new genus, new species, China

***Parafuscoptilia* gen. nov.**

Type Species. *Parafuscoptilia tubuliformis* sp. nov.

Description. Head (Fig. 2) with appressed scales, without frontal tuft; scales on vertex porrect or slightly reclinate. Labial palpi porrect, about twice length of eye diameter. Cervix with numerous dispersed erect scales.

Wings. Forewing (Fig. 3) cleft from $3/5$ to $2/3$, lobes with slightly concave outer margin, apex moderately pointed. Sc reaching $2/5$ costal margin; R_1 absent, R_2 free, R_3 stalked with R_4 , R_4 nearly reaching apex of first lobe, R_5 reaching inner margin at about $3/5$ length of first lobe; M_3 reaching apex of second lobe; Cu_1 from $1/3$ of M_3 in second lobe, Cu_2 from before angle of cell. Hindwing (Fig. 3) cleft from $1/2$ and $1/5$; first lobe evenly narrow; second lobe with outer margin somewhat concave; third lobe evenly narrow, without "scale tooth." Sc+ R_1 reaching $1/2$ costal margin, third lobe with only one vein.

Abdomen short and small.

Male genitalia: Uncus nearly trapezoidal, sclerotized. Tegumen broad, with distal portion tube-like. Valvae symmetrical, tapering distally. Anellus absent, but manica present. Aedeagus stubby, spinous.

Female genitalia: Apophyses posteriores slender; apophyses anteriores short and broad. Ostium and antrum centrally positioned. Corpus bursa without signum, but with spinules.

Differential Diagnosis. *Parafuscoptilia* gen. nov. is characterized by the male genitalia with the distal portion of the tegumen tubiform, the uncus nearly trapezoidal, and the valva tapering distally. The new genus is most similar to *Fuscoptilia* Arenberger (1991) (Arenberger, 1991; Gielis, 1993, 2003; Ustjuzhanin, 1996), but can be distinguished from the latter by the following characters: R_1 of the forewing is absent in *Parafuscoptilia* gen. nov., but present in *Fuscoptilia*; Sc+ R_1 of the hind wing in *Parafuscoptilia* extends to $1/2$ of costal margin, while it nearly reaches the apex of the costal margin in *Fuscoptilia*; the uncus is nearly trapezoidal in *Parafuscoptilia*, but somewhat rectangular or spherical in *Fuscoptilia*; the valva is tapering distally and pointed at apex in *Parafuscoptilia*, but broad and rounded at apex in *Fuscoptilia*; the basal section of the aedeagus is simple in *Parafuscoptilia*, but bifurcated in *Fuscoptilia*; the

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corpus bursa is small and bears numerous fine spines on the inner surface in *Parafuscoptilia*, while it is very large and does not possess spines in *Fuscoptilia*.

Remarks. The tubiform distal portion of the tegumen in *Parafuscoptilia* is not found in other Pterophoridae. The tapering distal section of the valva in *Parafuscoptilia* can also be found in *Antarches* (Gibeaux, 1994) and *Megalorhipida* (Gielis, 1993, 2003; Gibeaux, 1994), but the new genus can be separated from them by the simpler, not S-shaped, valva and the slender aedeagus. In general, the manica is absent in Pterophoridae, but it is present and tightly surrounds the stout aedeagus in *Parafuscoptilia* and *Fuscoptilia*, which might be a synapomorphy for these two genera.

Etymology. The generic name is derived from the Greek *para* = beside, near, and the generic name *Fuscoptilia*, in reference to the similarity of male genitalia in the two genera.

Parafuscoptilia tubuliformis sp. nov.

Figs. 1-2

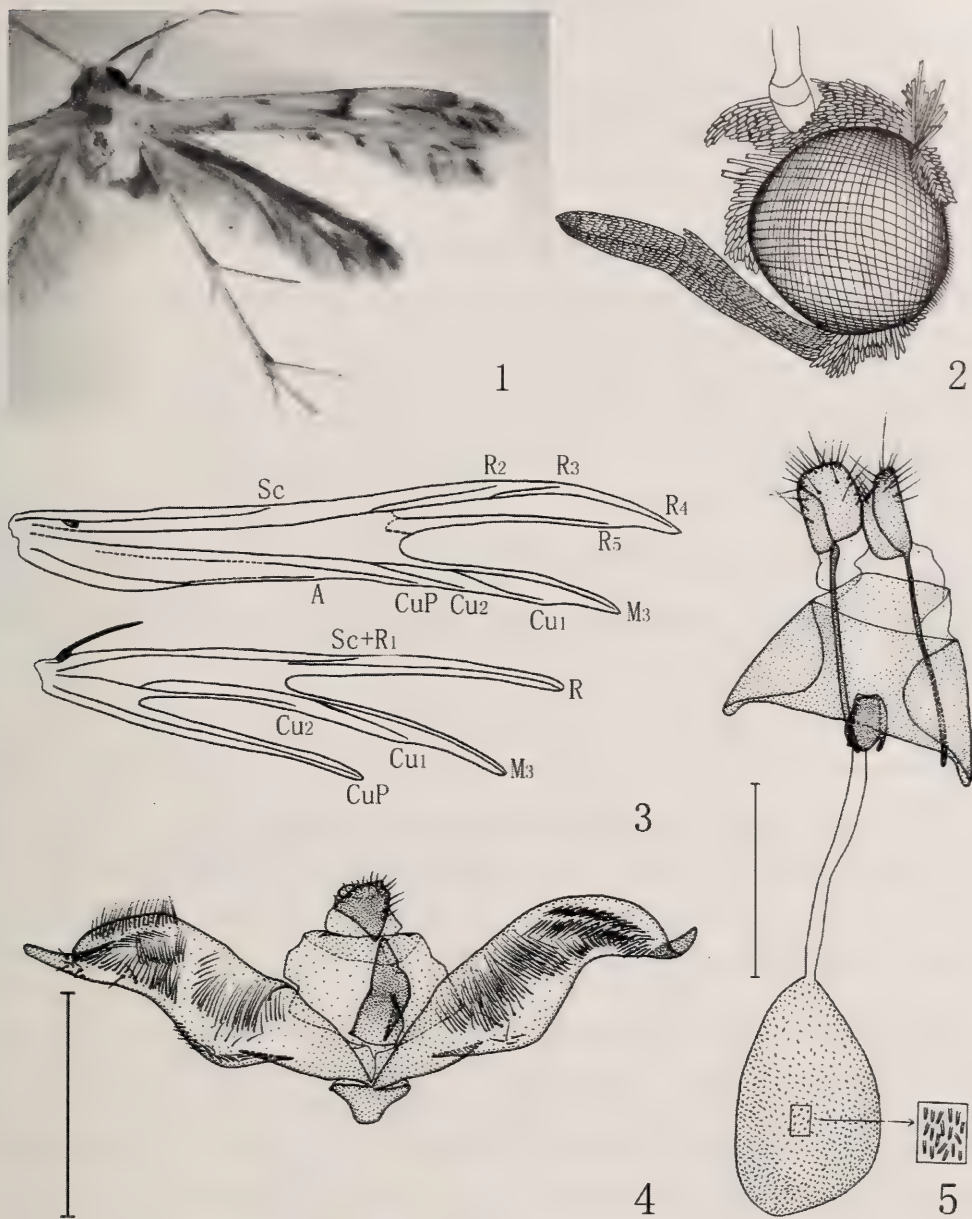
Type Data. Holotype ♂: **China**, Putian County (24.26° N, 119.01° E), Fujian Province, 30. Jul. 1978, genitalia slide No. HSL02307. Paratypes: 5 ♂♂, 2 ♀♀, same locality as holotype, from 30. Jul. 1978 to 4. Aug. 1978. Holotype and 2 ♂♂, 1 ♀ of paratypes deposited at the Institute of Zoology, Chinese Academy of Sciences (IZCAS), Beijing, China; other paratypes deposited at the Department of Biology, Nankai University (DBNU), Tianjin, China.

Description. Head yellowish white to ivory white, roughly scaled. Antenna about 2/5 length of forewing; scape slightly expanded, yellowish white to ivory white; flagellum yellowish white, except for brown end of each segment on dorsal surface, ventral surface with dense cilia. Labial palpus with basal segment yellowish white, slightly enlarged; second segment ivory white, appressedly scaled; apical segment somewhat thin, as long as second segment, pointed. Numerous erect apically bifurcated short scales dispersed along margin of occiput and cervix. Thorax brown, with yellowish-white to ivory-white scales. Tegula buff to ivory white. Legs with outer surface greyish brown to pale brown, inner surface yellowish white to ivory white.

Wingspan 11.0-14.0 mm. Forewing white, with yellowish-white margins; with small, pale brown spot situated at 1/3 near costa; with pale brown spot at basal 1/4 on inner margin; cleft with a pale brown triangular spot; lobes with distal section alternately pale brown and ivory white; apices ivory white; fringe of first lobe yellowish white to ivory white, inner margin mixed with grayish brown; fringe of costal margin of second lobe concolorous with markings of second lobe, but brown near apex, inner margin yellowish brown to ivory white, evenly mixed with brown scales. Hindwing and its fringe evenly grayish brown to grayish white.

Male genitalia (Fig. 4): Uncus arising from distal 1/3 of tegumen ventrally, relatively sclerotized, moderately setose. Tegumen with distal 1/3 tubiform, weakly sclerotized. Valvae more or less S-shaped, densely covered with fine hairs, with apex sharp, somewhat spine-like; costa simple, distal half gently arched except apex; ventral margin protruded medially, distal 1/3 incurved. Manica tightly surrounding aedeagus. Saccus short, rounded at apex. Aedeagus simple, basal 1/2 wide, nearly parallel-sided, distal 1/2 gradually narrowing toward apex, somewhat subtriangular.

Female genitalia (Fig. 5): Papillae anales subrectangular, with long setae. Apophyses posteriores slender, about twice length of 8th sternite. Apophyses anteriores stout, about 1/4 of 8th sternite. Ostium small. Antrum heavily sclerotized, with small process arising from lateral side at anterior 1/3. Ductus bursae membranous, as long as apophyses posteriores. Corpus bursae somewhat pyriform, vesicular, relatively small, shorter than ductus bursae, inner surface densely spinulose.



Figs. 1-5. *Parafuscoptilia tubuliformis* gen. sp. nov.: 1. adult; 2. head; 3. venation; 4. male genitalia (gen. slide no. HSL02307); 5. female genitalia (gen. slide no. HSL02276) (scales = 0.5 mm).

Diagnosis. The new species is related to *Fuscoptilia emarginata* (Snellen, 1884) (Yano, 1963; Arenberger, 1991), but can be easily separated from the latter by the tubiform distal portion of the tegumen, the nearly trapezoidal uncus, the distally tapering valva and the simple basal portion of the aedeagus in the male genitalia; the antrum with a small process arising from the lateral side at anterior 1/3 and the corpus bursae somewhat pyriform in the female genitalia.

Etymology. The new specific name is derived from the Latin *tubuliformis* = tubiform, in reference to the distal shape of the tegumen in the male genitalia.

ACKNOWLEDGEMENTS

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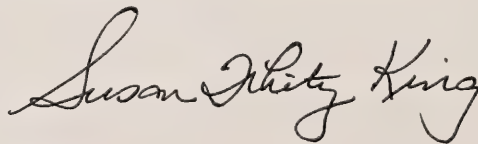
LETTER FROM THE PRESIDENT OF THE AMERICAN ENTOMOLOGICAL SOCIETY

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Sincerely,



Susan Whitney King
President, American Entomological Society

**INTRODUCTION OF THE CENTIPEDE *SCOLOPENDRA MORSITANS* L., 1758, INTO NORTHEASTERN FLORIDA, THE FIRST AUTHENTIC NORTH AMERICAN RECORD, AND A REVIEW OF ITS GLOBAL OCCURRENCES
(SCOLOPENDROMORPHA: SCOLOPENDRIDAE: SCOLOPENDRINAE)¹**

Rowland M. Shelley,² G. B. Edwards,³ Amazonas Chagas Jr.⁴

ABSTRACT: The centipede *Scolopendra morsitans* L., 1758, is recorded from North America and the continental United States based on an exogenous individual from Jacksonville, Duval County, Florida; it is also documented from Curaçao. The species has now been reported from all the inhabited continents, but the European citations — from France, Italy, Turkey (Istanbul), Russia/Georgia (Caucasus), and Armenia — are dubious. With extensive records from the interiors, well removed from ports, *S. morsitans* appears to be native to Australia and Africa, occurring throughout these continents except for most of Victoria, adjacent South Australia, and southwestern Western Australia in the former, and the Eritrean Highlands and Red Sea Hills in the latter; it also seems to be native to southern/southeastern Asia from Pakistan to New Guinea, southeastern China, Taiwan, and the Philippines. New World occurrences — extending from Florida, Mexico, and the Bahamas to Peru and northern Argentina — are sporadic and interpreted as introductions or possible misidentifications. While absent from the eastern Pacific, Tasmania, and New Zealand, *S. morsitans* occurs on many islands and archipelagos in the Atlantic, Indian, and western and central Pacific Oceans, apparently being indigenous to Madagascar and Sri Lanka, and introduced to the rest. However, occurrences on the Canary and Cape Verde Islands may represent rafting from Africa and thus natural range extensions.

KEY WORDS: *Scolopendra morsitans*, introduction, Florida (U.S.A.), Europe, Africa, Asia, Australia, New World, islands

Because of its moist, subtropical environments and its location as the southeasternmost Atlantic Coastal state, Florida is a haven for introduced organisms. Of 54 species in the arthropod class Diplopoda, Shelley (2001, 2002a, b) documented 12 exogenous Neotropical or Oriental species, one of which, *Myrmecodesmus digitatus* (Loomis, 1959) (Polydesmida: Pyrgodesmidae), he (Shelley 2004a) subsequently concluded is indigenous to the Gulf Coastal Plain. Additionally, there is at least one exogenous species in the family Rhinocricidae (order Spirobolida), tentatively assigned to the Neotropical genus *Eurhinocricus* Brölemann (Shelley and Edwards 2002), that is now established in the Keys, particularly in plant nurseries. Consequently, nearly one-fourth (22.2 percent) of the Floridian diplopod fauna is non-native.

In comparison to millipeds, the centipede fauna of Florida is poorly known. The introduced Palearctic scutigermorph, *Scutigera coleoptrata* L., 1758,

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which is widespread in North America, surely occurs there, but the only order that has been investigated in depth is the Scolopendromorpha (Shelley and Edwards 1987, Shelley 2002c), which comprises nine species (Table 1) with the Neotropical chilopod *Rhysida longipes longipes* (Newport, 1845) (Scolopendridae: Otostigmidae) being allochthonous. Shelley (2002c) did not regard it as established in Florida, but a recent sample from Hialeah suggests that reproducing populations may exist in Miami-Dade County (Shelley and Edwards 2004). We report here the discovery of a second introduced scolopendrid, *Scolopendra morsitans* L., 1758 (Scolopendridae: Scolopendrinae), in Duval County, which was intercepted once in quarantine in Philadelphia (Shelley 2002c). This is the first authentic record of *S. morsitans* from the continental United States and North America as a whole; previous citations from Big Springs, Howard County, Texas, and Texas, Florida, Georgia, New York, Kansas, Utah, and California in general (Cragin 1885; Underwood 1887; Daday 1889; Chamberlin 1911; Gunthorp 1913, 1921; Chamberlin and Mulaik 1941; and Kevan 1983) are misidentifications of other scolopendrids (Shelley 2002c). On July 30, 2004, John A. Smith, an inspector with the U.S. Department of Agriculture, discovered an individual of *S. morsitans* climbing the base of a peach tree outside a home in the Mayport area of Jacksonville, approximately 4.5 mi (7.2 km) south of Fort Caroline National Memorial; because it was found in a residential area well away from the Port of Jacksonville, *S. morsitans* must be considered a true introduction into northeastern Florida. The specimen was sent to the second author, where it was accessioned as Florida State Collection of Arthropods sample E-2004-5618, and then to the first author for determination. It exhibits the triangular spiracles characteristic of the Scolopendrinae and the diagnostic features of *Scolopendra* (the cephalic plate overlapping T1 and a prominent ventrodistal spur on the proximotarsus of each leg), but it lacks the procurved transverse sulcus on T1, sulci on the cephalic plate, and spines dorsally on the prefemora of legs 18-20. Consequently, it is not a juvenile of *S. alternans* Leach, 1813, which lacks the first feature but possesses the last two and occurs in Collier, Miami-Dade, and Monroe counties in south Florida (Shelley 2002c). There is a median suture on T21 [as in the Australian individual of *S. morsitans* illustrated by L. E. Koch (1983:84, fig. 10)], seven ventral spines arranged in three rows (2, 3, 2) on the ultimate prefemur of the right leg, and nine spines arranged in five rows (2, 3, 2, 2, 1) on that of the left leg (Fig. 1), which are comparable to spine arrangements in individuals from Puerto Rico (Shelley 2002c:40, fig. 57). Likewise the size, 56.5 mm long and 5.7 mm wide, is consistent with *S. morsitans*, a small-bodied scolopendrid, and the specimen compares favorably with an authentic individual in the the first author's institution from Queensland, Australia, where *S. morsitans* is common (L. E. Koch 1983). Though not diagnostic, the antennae reach backwards to near midlength of T3, have 19 and 17 articles on the left and right ones, respectively, and the basal 5½ articles are sparsely hirsute. Its color is distinctly different from the two sympatric native scolopendrids — *S. viridis* Say, 1821 (generally greenish) and *Hemiscolopendra marginata* (Say, 1821) (bluish or blue-gray) (Shelley 1987, 2002c; Shelley and Edwards 1987; Hoffman and Shelley 1996): cephalic plate, forcipules, coxosternum, T1, S1 and S21, and 1st and ultimate legs orange; T2-19 pale yellow with prominent bluish-brown transverse bands along caudal margins comprising 20-40

percent of tergal lengths; T20 with narrow, interrupted caudal band constituting ca. 10 percent of tergal length; T21 completely yellow; S2-20 and associated legs generally yellowish and becoming progressively darker caudad.

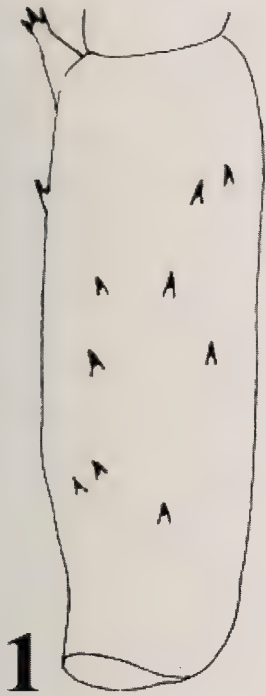


Fig. 1. Prefemur of left caudal leg of specimen of *S. morsitans* from Jacksonville, Florida, U.S.A., ventral view.

Table 1. Representatives of the chilopod order Scolopendromorpha in Florida (*introduced species).

Family Scolopendridae

Subfamily Scolopendrinae

Scolopendra alternans Leach, 1813 – Collier, Miami-Dade and Monroe Cos.

**S. morsitans* L., 1758 – Duval Co.

S. viridis Say, 1821 – statewide

Subfamily Otostigminae

**Rhysida longipes longipes* (Newport, 1845) – Miami-Dade Co.

Family Scolopocryptopidae

Subfamily Scolopocryptopinae

Scolopocryptops nigridius McNeill, 1887 – Jackson Co.

S. sexspinosus (Say, 1821) – statewide

Family Cryptopidae

Subfamily Cryptopinae

Cryptops floridanus Chamberlin, 1925 – peninsular Florida from Alachua, Gilchrist, and Putnam counties southward.

C. leucopodus (Rafinesque, 1820) – statewide

Subfamily Plutoniuminae

Theatops posticus (Say, 1821) – statewide

Scolopendra morsitans, the fifth species described in *Scolopendra* L., 1758, was designated the type species in 1957 under the plenary powers of the International Commission on Zoological Nomenclature (Opinion 454), in response to the petition by Crabill (1955). The type locality is India, and the first author found the holotype, a dry specimen labeled *S. morsitans*, on a pin in the Linnaean Collection at the Linnean Society of London during a visit in 1997. According to Attems (1930a), there are some 48 synonyms, and four subspecies have been proposed: *S. m. scopoliana* C. L. Koch, 1841, described as a full species from Algiers, placed in synonymy under *S. morsitans* by Kohlrausch (1881), elevated to a subspecies (= "variety") by Kraepelin (1903), and retained in that status by Attems (1930a); *S. m. calcarata* Daday, 1891, from an unknown locality, which was placed in synonymy under *S. morsitans* by Kraepelin (1903) and retained in that status by Attems (1930a); *S. m. fasciata* Attems, 1930, from Angola, which was placed in synonymy by Würmli (1975); and *S. m. amazonica* Bücherl, 1946, from Manaus, Amazonas, Brazil. The first remains a subspecies that ostensibly occurs in Morocco, Algeria, and Tunisia, and was encountered as an introduction near Marseilles, France; *S. m. amazonica*, however, was elevated to full species status by Jangi (1959). The relative statuses of *S. morsitans* and *S. amazonica* have been extensively debated, and

like L. E. Koch (1983) and Lewis (2002), we accept the opinion of Würmli (1975, 1978), who investigated this matter and concluded that the names are synonymous. *Scolopendra morsitans* (= *S. amazonica*) is thus a widespread, cosmopolitan centipede that has now been recorded from all the inhabited continents, but much of its distribution is an artifact reflecting extensive human introductions. The species is abundant in Africa and Australia, occurring well inland and away from ports (Figs. 4-6), so we believe *S. morsitans* is native to these continents as did L. E. Koch (1983); these factors also apply to mainland southeast Asia from coastal Pakistan eastward (Fig. 5). Likewise, *S. morsitans* occurs throughout Taiwan and Indonesia, and is surely native there too although some localities may represent introductions. Records exist from only four islands in the Philippines, too few to draw a definitive conclusion, but we suspect that *S. morsitans* is also native to this archipelago, which lies between Taiwan and Indonesia. Its sporadic occurrence in the New World, primarily on islands and at ports or coastal locations, undoubtedly reflects human importations, and Shelley (2002c) cited ones from the West Indies, Mexico, and Central America. Numerous published records of *S. morsitans* exist in scores of papers, and it is timely to consolidate and map them. We therefore scoured the first author's personal library and present below a list of all records of *S. morsitans* that we know of in modern geopolitical terminology with old names in parentheses; states or provinces (in italics) are provided for certain countries, and islands in archipelagos are also italicized. We could not place some localities nor determine their modern names, and these are denoted by asterisks. Occurrences are mapped in Figs. 2-6, with specific localities indicated by dots and unsupplemented records from countries or islands in general, by triangles. Lewis (2001a) reexamined 13 of Chamberlin's specimens (1958) of "*S. morsitans*" from Bahrain and Iraq, and discovered that they were actually other species; he stated, "it seems very unlikely that *S. morsitans* occurs in Iraq and Chamberlin's records for that country should be disregarded." Lewis added that *S. morsitans* had not been reported from Israel, Lebanon, Jordan, Syria, Iraq, Iran, or Saudi Arabia and that the only reliable records from the Arabian Peninsula are from the coasts of Oman and Yemen (Lewis 1996). However, there are old literature reports from Syria in general (Brölemann 1904a) and the Elburz Mountains in northern Iran (Silvestri 1935), which are isolated and suspicious. No one knows how many and which records represent additional misidentifications; this would require reexamining all the samples that are scattered through major global repositories, a prohibitive amount of work. However, the Syrian, Iranian, and several other records, indicated by question marks (?) on Figs. 4-5, are so disparate from areas where localities cluster that they likely reflect misidentifications or, at best, isolated, one-time importations. Consequently, the ensuing list and maps are undoubtedly imperfect and contain undetected errors, but we believe they constitute beneficial information for chilopodology. The list contains the few published records of *S. m. scopoli* and is divided into regions of the world with countries arranged alphabetically; general range statements are provided first followed by specific localities, all documented with citations. For completion and historical interest we preface the list with prior overall range statements, none of which are truly accurate.

As shown in Figs. 2-6, *S. morsitans* has been reported from the six inhabited continents, but all the records from Europe and the Middle East are dubious at best, except those from Yemen and Oman (Fig. 4). In the New World, occurrences are sporadic and primarily from islands or coastal sites between the Tropics of Cancer and Capricorn, which suggest accidental human importations; localities on the Amazon River and tributaries in Brazil and Peru, like Manaus, also are ports and indicate the same. Pocock (1895a) recognized this and stated that the centipede was "artificially introduced" to Tamaulipas and Veracruz, Mexico. Records from the interiors of Colombia, Peru, Brazil, Paraguay, and Argentina are not verifiable and may or may not be accurate, but we accept them for now. Consequently, New World occurrences extend from Florida, central Mexico/southern Baja California, and the Bahamas to central Peru and northern Argentina, and we here newly record it from Curaçao. The only countries, territories, and major islands in the hemisphere from which *S. morsitans* has not been cited are Canada, Guatemala, Honduras, El Salvador, Nicaragua, Bolivia, Uruguay, and Chile, on the continents, and the British Virgin Islands, Saba, St. Martin, St. Eustatius, St. Lucia, Barbados, Grenada, Aruba, Bonaire, Margarita Island, and Trinidad, in the Caribbean.

In the Old World, there is no recent evidence that *S. morsitans* occurs in Europe or the Middle East except for the sites in Yemen and Oman, which, being coastal, logically represent introductions. The species occurs throughout Africa except for the Eritrean Highlands in Eritrea and northern Ethiopia, its northern extension, the Red Sea Hills, of eastern Sudan and plausibly also southern Egypt, and the narrow coastal strip bordering the Red Sea in these countries (J. G. E. Lewis, pers. comm. to RMS) and the southwestern corner of South Africa, including the Cape Peninsula, where it is replaced by *Arthrorhabdus formosus* Pocock, 1891 (Lawrence 1936, 1938, 1955). The only species of *Scolopendra* that Brölemann (1901a, 1904b) and Lewis (1969a) recorded from Eritrea and adjacent areas were *S. valida* Lucas, 1840, and *S. mirabilis* (Porat, 1876), so we believe that *S. morsitans* is truly absent from this part of the continent. The other sizeable voids on the African map (Fig. 4) are the inaccessible central Sahara and the northwestern Democratic Republic of the Congo (DRC) and adjoining countries. However, outlying records from Mali and Chad document occurrence in the Sahara, and the preponderance of records from southern Sudan and eastern DRC suggest that the latter hiatus reflects inadequate collecting. Thus, excepting the Eritrean Highlands and Red Sea Hills, we believe *S. morsitans* can be expected throughout Africa, and the numerous records from deep in the interior, well removed from ports, indicate native occurrence on this continent. In Africa, therefore, *S. morsitans* is known from 33 of the 46 countries, being unrecorded from the Moroccan territory of "Western Sahara" and Mauritania, Guinea Bissau, Sierra Leone, Togo, Niger, Central African Republic, Eritrea, Djibouti, Equatorial Guinea, Congo, Bwanda, Burundi, and Malawi, with the absences from Eritrea and possibly also Djibouti considered real.

In Asia and Australia, *S. morsitans* extends from coastal Pakistan to the Ryu Kyu Islands (Okinawa), New Guinea (known only from Irian Jaya but surely also in Papua New Guinea), and Australia, where it is widespread but absent from the southwestern corner of Western Australia, the southeastern corner of South Australia, and essentially all of Victoria, except for the inner border area with New

South Wales and Melbourne, a major port, where the one recorded individual is an obvious human importation (L. E. Koch 1983, fig. 16 [map]) (Fig. 5). According to this author, it is absent from Tasmania and all of New Zealand, a conclusion that we accept although there are two records from New Zealand in general (Daday 1889, Würmli 1975). Many sites are in the interiors of India, Myanmar, Laos, and Australia, well removed from ports, so we believe the centipede is native here too; most Indonesian records probably also reflect indigenous occurrences. Widely disjunct records, detached from this continuous area, include the aforementioned Elburz Mountains in Iran, Beijing, China, and Japan in general, all denoted by question marks (Fig. 5). *Scolopendra morsitans* has been collected repeatedly on Taiwan, and occurrence on Okinawa is plausible both because of its proximity to Taiwan and because it is a small island where exogenous species typically abound. The records from Japan in general (Wood 1862, Chamberlin and Wang 1952) are non-specific and could refer to any island or even the Ryu Kyus, and we arbitrarily place a question mark in central Honshu. The Beijing record (D. Wang and Mauriès 1996) could represent an introduced specimen, but we show it with a question mark because it is so disjunct. Khanna (2001) summarized Indian occurrences and reported *S. morsitans* from all the states, so we shade the entire country including Kashmir. However, *S. morsitans* may be absent from this area because of its high elevations, as other records suggest that it occurs primarily at lower altitudes. Kohlrausch (1881) did report it from “Himalaya” without further specification, implying high elevations, but the only other records from such heights are those of Khanna (2001 and references therein). The centipede has not been recorded from Nepal or Bhutan but is expected in border areas adjacent to India. Other than the dubious record from Beijing, it also is unknown from the Palaearctic part of Asia, north of the Himalayas, which includes seven countries — Tajikistan, Kyrgyzstan, Uzbekistan, Turkmenistan, Kazakstan, Russia, and Mongolia.

Scolopendra morsitans inhabits many islands in the Atlantic, Pacific, and Indian Oceans (Figs. 5, 6), and has been introduced to most of these including all those in Oceania (Shelley 2004b). It is surely indigenous to Sri Lanka, given its abundance in nearby southern India, and also Madagascar, where we shade the entire island (fig. 5) although most records are from coastal sites. It is probably introduced to the other Indian Ocean Islands — Andaman and Nicobar Islands, the Mascarenes, Seychelles, and Comoros — though those closest to Africa and Madagascar could result from rafting. In the Atlantic, *S. morsitans* has been recorded primarily from islands close to the African and South American continents — Fernando Noronha, the Canaries, and Cape Verdes; occurrence in Fernando Noronha must reflect human agency, but its presence in the last two could plausibly result from rafting from Africa, where the species is common. However, St. Helena is so far from the African mainland that its presence there must reflect human activity. Of interest is the fact that *S. morsitans* has not been recorded from the eastern Pacific Ocean; for example Shear and Peck (1992) do not cite it from the Galápagos nor does Shelley (2004b) record it from the Juan Fernández Islands, Easter and Pitcairn Islands, or Cocos Islands. While there are fewer islands and archipelagos in this vast area than in the western and central Pacific, some have seen enough human activity that *S. morsitans* may be encountered in the future.

Review of its Global Occurrences

PUBLISHED OVERALL RANGE CITATIONS: WORLDWIDE (Haase 1887 ["Territor. univ."]). VAST DISTRIBUTION (Silvestri 1895a). COSMOPOLITAN OR NEARLY COSMOPOLITAN (Bollman 1893; Kraepelin 1903; Attems 1907a, 1909a, 1910a, 1914, 1915, 1930a, 1934a; Chamberlin 1914a; Chelazzi 1977; Lawrence 1936, 1955; Lewis 1984; L. E. Koch 1983, 1984); "Kosmopolitisch über alle Länder der wärmeren und gemäßigten Zone verbreitet" (Attems 1914). WARM REGIONS (Kohlrausch 1881 ["in regionibus calidioribus terrarum omnium"]), (Attems 1930a, Chamberlin 1951, L. E. Koch 1983 [Tropics and warm parts of temperate zone]), (Bollman 1893, Chamberlin 1911, Brolemann 1932 [Common in tropical, subtropical, and temperate zones]). TROPICAL AND SUBTROPICAL (Pocock 1895a; Kraepelin 1903; Attems 1928, 1934a; Silvestri 1894, 1895b, 1935; Lawrence 1936; Bücherl 1939; Crabill 1960; Dobroruka 1969; Lewis 1969b, 1996; Würmli 1972), (Meinert 1886 ["all tropical regions, whence it is often brought alive in ships to more northern localities"]); particularly occurring in oriental and African regions (Kraepelin 1903).

NORTH AMERICA: USA: *Florida*, Duval County (present contribution). **MEXICO AND CENTRAL AMERICA:** MEXICO (Kohlrausch 1881, Brölemann 1909): *Baja California Sur*; San Jose del Cabo (Shelley 2002c). *Colima* (Brölemann 1904a). *Tamaulipas*; Tampico (Kohlrausch 1881, Pocock 1895a). *Veracruz* (Kohlrausch 1881, Pocock 1895a, Bollman 1893), Tuxpan (Shelley 2002c). *Yucatán*; Cayo Aremas (a small island NW Progreso) (Shelley 2002c). **BELIZE:** Belize City (Chamberlin 1921, Shelley 2002c). **COSTA RICA:** Banana River* (Shelley 2002c). **PANAMA** (Chamberlin 1921).

CARIBBEAN ISLANDS: WEST INDIES/CARIBBEAN ISLANDS/ANTILLES (Griffith and Pidgeon 1832; Newport 1845, 1856; Underwood 1887; Bollman 1893; Brölemann 1909). **ANGUILLA** (Shelley 2002c). **ANTIGUA:** Cambridge, Dickinson Bay, and Marmora Point (Shelley 2002c). **BAHAMAS:** *Eleuthera*, *Exuma* (Shelley 2002c). *New Providence*; Nassau (Chamberlin 1918). **BARBUDA** (Shelley 2002c). **CAYMAN ISLANDS:** *Grand and Little Cayman Islands* (Shelley 2002c). **CUBA** (Pocock 1893, Brölemann 1904a). **CURAÇAO:** Coral Specht, 3 km E Willemstad, 2 specimens, 8-15 November 1987, W. E. Steiner, J. M. Swearingen (National Museum of Natural History, Smithsonian Institution, Washington, DC, USA) **New Record**. **DOMINICA:** Roseau (Brölemann 1904a). **DOMINICAN REPUBLIC** (Pocock 1893): Azua, San Juan (Shelley 2002c). **GRENADINES:** *Bequia* (Shelley 2002c). **GUADELOUPE:** Basse Terre, Grande Terre (Demange 1981). **HAITI:** Jérémie, Grand Anse, St.-Marc (Pocock 1893, Chamberlin 1918). Port-au-Prince (Pocock 1893, Chamberlin 1918, Shelley 2002c). **JAMAICA** (Pocock 1893, Bollman 1893): *St. Andrews Par.* (Shelley 2002c). **MARIE GALANTE** (Demange 1981). **MARTINIQUE** (Brölemann 1904a, Shelley 2002c). **MONTSERRAT** (Shelley 2002c). **NEVIS** (Shelley 2002c). **PUERTO RICO** (Chamberlin 1918); San Juan (Shelley 2002c). **ST.-BARTHÉLEMY** (Pocock 1893). **ST. KITTS** (Pocock 1893, Bollman 1893, Chamberlin 1918, Shelley 2002c). **ST. VINCENT** (Brölemann 1904a, Shelley 2002c). **TRINIDAD AND TOBAGO:** *Tobago* (Newport 1845, 1856; Kohlrausch 1881; Bollman 1893). **TURKS AND CAICOS ISLANDS:** *Grand Turk*, *S. Caicos*, and *W. Caicos Islands* (Shelley 2002c). **USVIRGIN ISLANDS:** *St. Thomas* (Bollman 1893, Brölemann 1904a, Shelley 2002c). *St. Croix* (Shelley 2002c).

SOUTH AMERICA: ALMOST ALL SOUTH AMERICAN COUNTRIES (Bücherl 1939). **GUYANA, SURINAM, AND FRENCH GUIANA** (Guyanas) (Brölemann 1909). **ARGENTINA** (Brölemann 1909): Chaco (Silvestri 1895c). **BRAZIL** (Kohlrausch 1881, Brölemann 1909): *Amazonas* (Bücherl 1939, 1941); Manaus (Brölemann 1901b, 1903, 1904a, 1909; Chamberlin 1914a; Bücherl 1946, 1974; Chagas 2000; Schileiko 2002). *Bahia*; Salvador (Bücherl 1974). *Goiás* (Bücherl 1939). *Mato Grosso* (Bücherl 1939, 1941). *Pará* (Bücherl 1939); Belém (Pará) (Brölemann 1902a, 1902b, 1904a, 1909; Chamberlin 1914a; Bücherl 1974; Schileiko 2002); Santarem (Chamberlin 1914a). *Paraíba*, Paraíba (Chamberlin 1914a). *Rio de Janeiro*; Rio de Janeiro (Bollman 1893, Chamberlin 1914a). *São Paulo* (Brölemann 1901c, Bücherl 1941); São Paulo (Bücherl 1974). **COLOMBIA** (New Granada) (Kohlrausch 1881, Bollman 1893, Brölemann 1909, Bücherl 1974): *Casanare*; Orocué (Attems 1903). *Cordoba*; Darien (Brölemann 1904a). Meta; Villavicencio (Attems 1903). **ECUADOR** (Campos-Rebeiro 1926): Rio Napo (Brölemann 1904a). **FRENCH GUIANA:** Cayenne (Bollman 1893, Brölemann 1904a). **GUYANA:** Demerara River (Newport 1845, 1856; Porat 1893; Bollman 1893). **PARAGUAY** (Brölemann 1909): Rio Apa (Silvestri 1895c). **PERU:** *Huanuco*; La Merced (Bücherl 1950). *La Libertad*; Huamachuco (Kraus 1957, Bücherl 1974). *Loreto*; Santa Elena (Kraus 1957). *San Martin*; Juanjui (Yanjui) (Kraus 1957, Bücherl 1974). **SURINAM** (Kohlrausch 1881, Underwood 1887, Jeekel 1952); Paramaribo (Bollman 1893). **VENEZUELA** (Brölemann 1909).



Fig. 2. Occurrences of *S. morsitans* in the New World. Dashed lines represent the Tropics of Cancer and Capricorn; the solid line represents the Equator. Dots, approximate locations of specific records; triangles, unsupplemented records from countries and islands in general. The dots off the Yucatan peninsula of Mexico and the tip of Brazil represent the records from Cayo Arema, and Fernando de Noronha, respectively. The outlined area is enlarged in Fig. 3.



Fig. 3. Occurrences of *S. morsitans* on Caribbean Islands and neighboring areas. Lines and symbols as in Fig. 2.

ATLANTIC OCEAN ISLANDS

CANARY ISLANDS (Kohlrausch 1881, Brölemann 1909). CAPE VERDE ISLANDS (Porat 1893, Brölemann 1904a, Attems 1930a, Lewis 1969b): São Vicente (Lewis 1969b). FERNANDO NORONHA: Main island (Pocock 1890). ST. HELENA (Cook and Collins 1893, Attems 1907a).

EUROPE

PALAEARCTIC REGION IN GENERAL (Attems 1930a). ARMENIA: Jerevan (Erivan) (Brölemann 1909). FRANCE: discovered at ports with merchandise from exotic provinces (Brölemann 1930). Marseilles vicinity (Turk 1951). ITALY (Brölemann 1904a, Schileiko 1995). RUSSIA/GEORGIA: Caucasus (Daday 1893, Attems 1907b). TURKEY (Schileiko 1995): Istanbul (Kohlrausch 1881, Attems 1930a).

AFRICA

AFRICA IN GENERAL (Newport 1844). ALMOST THROUGHOUT THE AFRICAN CONTINENT (Kohlrausch 1881, Lewis 1969b, Lawrence 1975, Schileiko 1995, Chagas 2000). AFRICA EAST OF THE SAHARA (Lewis 1984). COASTAL REGION OF EAST AFRICA (Ribaut 1914). WEST AFRICA (Lewis 1969b). TROPICAL AND SOUTHERN AFRICA (Manfredi 1941). SOUTHERN AFRICA (Lawrence 1936, 1955). ALGERIA (Brölemann 1921, Lewis 1984): Alger (C. L. Koch 1847, 1863; Kraepelin 1903; Brölemann 1904a, 1921, 1931; Attems 1930a); Arzew, mountains nr. Boghar, Tlemcen (Brölemann 1904a); Batna, Oran (Attems 1902); Biskra (Brölemann 1904a, Lewis 1969b); Chrea Nat. Pk. (Brölemann 1931); Guelt es Stel (Lewis 1969b, 1984); Miliana (Brölemann 1904a, 1921, 1931); Cèdres Peak* (Attems 1902); Hamman Righa, Constantine, Kherata,* Quarzazate* (Lewis 1969b). ANGOLA (Lewis 1966, 1969b; Schileiko 2002): Southern Angola (Lawrence 1959). *Lunda Sul Prov.* (Chamberlin 1951). Benguela, Bié (Lewis 1969b); Luanda (Cook 1893, Cook and Collins 1893); Chimpopo,* Rio Mbali* (Attems 1930b); Caquindo* (Attems 1930a, 1930c; Würmli 1975). BENIN: Dassari* (Demange 1972); Zagnanado (Brölemann 1926). BOTSWANA (Lawrence 1959): Kang, Lehutu, Kang-Kgokong,* Mookane,* Severelela-Kkakhea* (Attems 1909b); Okavango (Attems 1922); Ghanzi District, Molepolole, Kasane, Chukudukraal (Chukudu) near Kaotwe Pan, Tsotsoroga Pan,* Gembok Pan,* van Zyl's Cutting,* Damara Pan,* Titumi* (Lawrence 1936); Mashonoland (Lewis 1969b). BURKINA FASO: Ouagadougou and vicinity (Revault 1996). CAMEROON: Kumba (Dobroruka 1968); Bibundi,* Ekunda,* Kitta* (Porat 1894). CHAD: *Kanem Prov.* (Dobroruka 1968). CÔTE D'IVOIRE: Tiassalé (Brölemann 1904a). DEMOCRATIC REPUBLIC OF THE CONGO: "Congo" (Cook and Collins 1893). *Kivu* (Attems 1937). *Bandundu*; Lunda (Attems 1937). *Lower "Zaire"*; Banana (Chamberlin 1927, Attems 1937). *Maniem*; Kasongo (Attems 1937), Malela (Chamberlin 1927). *South Kivu*; Uvira (Attems 1930b, Dobroruka 1968), Luvunge (on Rusizi R. between lakes Kivu and Tanganyika) (Attems 1937). *Upper "Zaire"*; Bunia, Epulu R. (Dobroruka 1968); Garamba (Chamberlin 1927); Kulu (just south of Bondo) (Attems 1937). *Shaba (Katanga)* (Attems 1937); Kikondja (Attems 1937); Kiambi (Attems 1930b, 1937); Ankoro, Lukuga R. (Attems 1930b); Kateke riv. S of confl. with Lufira R., and Kabulumba, Kaulue N., Kanonga, Kaswabilenga, Kaziba, Kiamakoto/Kiwakishi, Kilwezi, Kipondo Riv., Mabwe, Masombwe, Mukana, all in Upemba National Park (Kraus 1958a). *Provinces Unknown*; Zambi* (Chamberlin 1927); Kalemie (Albertville), Kalelwé* (Attems 1930b); Gitega,* Muanda,* Mwema,* Urundi* (Attems 1937). EGYPT (Lewis 1969b): Alexandria, Cairo (Attems 1902); Aswan, Giza (Lewis 1984, 1967, 1985). ETHIOPIA: Ethiopia in general but not southern Ethiopia north-east of L. Turkana (L. Rudolph), between the Dawa River and L. Turkana/Omo River (Manfredi 1941, occurrences mapped by Lewis (1985, map 1)); Genalç River area of southern Ethiopia ("Alto Ganale Guddá") (Silvestri 1895a); "Magala re Umberto" ("King Humbert's Place, believed to be on Wab Shebel R. ca. 20 km N present border with Somalia [R. Hoffman, *in litt.* to RMS]) (Silvestri 1896); headwaters region of Genalç River ("Galla") (Brölemann 1904b); Adaleh (Chelazzi 1977, incorrectly placed in Somalia). GABON: Lamboréné (Brölemann 1904a); near Ogooué R. (Brölemann 1904a, Chamberlin 1927). GAMBIA (Brölemann 1904a): Bathurst (Lewis 1969b). GHANA: Mole Game Res. (Attems 1909c, d). GUINEA: *Kouroussa Prov.* (Brölemann 1904a). Late* (Dobroruka 1968). KENYA (Manfredi 1941): Athi Plains (Pocock, 1896); Gongoni, on the coast but exact location unknown (Lawrence 1953); Mombassa (Lewis 1969b); Longopito, on southern bank of Ewaso Ng'iro R, exact location unknown but near Samburu National Reserve (Dobroruka 1973); Elolo, modern name unknown but located on north-east shore of L. Turkana (L. Rudolph) (Manfredi 1941); Lamu and Manda islands (Attems 1910a). LESOTHO (BASUTOLAND) (Brölemann 1904a, Lewis 1969b). LIBERIA (Lewis 1969b). LIBYA: Tarâbulus (Tripoli) (Brölemann 1921). MALI: Tassakante, near Tombouctou, Sikasso (Brölemann 1904a); Kayes (Brölemann 1904a, 1905). MOROCCO (Kraepelin 1903, Brölemann 1921, Attems 1930a, Lewis 1984): Tétouan (Attems 1902); Amizmiz, Asni, Rabat, Mazagan (El Jadida), Marrakech,

Oued Tensift R., Fedhala,* Boulhaut,* Gorges de l'Oued,* Haute-Reraya,* Vallée de la Reraya,* Tiffssourme* (Brölemann 1945); E. of Mogodon* (Lewis 1969b). MOZAMBIQUE (Kohlrausch 1881): *Cabo Delgado*; Mecufi, Pemba (Lewis 2001b). *Maputo* (Lewis 2001b). *Zambezia*; Mopeia, on Cuacua (Quacua) R. (Attems 1896); Kasumbadedza, exact location unknown but on the Zambezi R. (Lawrence 1953). NAMIBIA (Lawrence 1975): "Hereroland" (a former homeland ca. 320 km N Windhoek) (Attems 1928); Omaruru, Swakopmund (Attems 1922); Okahandja (Attems 1909b); Windhoek (Attems 1909b, 1922). NIGERIA (Schileyko 2002): Northern Nigeria (Lewis 1969b, 1972); Southern Nigeria (Lewis 1969b); 31 localities named and mapped by Lewis (1978, fig. 2). Jos (Dobroruka 1968, Lewis 2001b); Kabwir (Lewis 2001b); Lake Chad (Lewis 2003); Malam Fatori, on western shore of Lake Chad (Lewis 1972, 1978); Pai River Game Res. (Lewis 2001b); Sokoto (Lewis 1978); Zaria (Lewis 1968, 1969b, 1970, 1978, 2003). SENEGAL (Lewis 1969b); Baraff/* (Demange 1985); Bignona Forest nr. Tabi, Linguère, Missira, Niokolo, Road to Kolda, Vélingara (Demange 1982); Saint Louis vicinity (Brölemann 1904a). SOMALIA (Manfredi 1941, occurrences mapped by Chelazzi [1977:71, fig. 1] and Lewis [1985, map 1]): "Frequent in humid southern zones near Juba (Giuba) and Webi Shabeelle (Uebi Scebeli) rivers, also present on the coast as far north as Xaafuun" (Hafun) (Chelazzi 1977); Brava, a tiny seaport just south of Muqdisho (Mogadishu) (Silvestri 1897, Chelazzi 1977); Lugh/Lugh Ferrandi, a site on the Juba (Giuba) R. just below 4° N (R. Hoffman, *in litt.* to RMS) (Silvestri 1897); Scioa* (Brölemann 1904b); Jawhar (Giohar) (Manfredi 1933 [cited as "Villaggio Duca degli Abruzzi] Chelazzi 1977); Muqdisho (Mogadishu), Gelib*, Obbia* (Chelazzi 1977); Bardera,* Alessandra,* Dante,* Cardero,* Lugh Dolo,* Siccome* (Manfredi 1933). SOUTH AFRICA (Attems 1930a, Chagas 2000): "All parts of South Africa, from Hereroland (in Namibia) to the Transvaal" (Attems 1928). "Found throughout South Africa except extreme southwestern corner, including Cape Peninsula, territory immediately bordering it, and the narrow coastal strip affected by winter rains" (Lawrence 1936). Central and Northern Transvaal, Mpumalanga, northern Cape, and KwaZulu-Natal Provs. (Lawrence 1959). Murchison Range, Transvaal, and Cape Prov. (Lewis 1969b). South of Orange River (Lawrence 1975). *Gauteng*; Pretoria (Lewis 1969). *KwaZulu-Natal*; Zululand (Lawrence 1955, Lewis 1969b); Mazimba Hill* (Attems 1934a); Mseleni, exact location unknown but near Ubombo (Attems 1934b); Nagana,* Umtalose Station* (Lewis 1969b). *Limpopo*: Murchison Range (Lewis 1969b). *Limpopo/Mpumalanga*; 11 sites in Kruger Nat. Pk. (Lawrence 1966). *Mpumalanga*; Kruger Nat. Pk., Malelane Camp (Attems 1934a). *Northern Cape*; Namaqualand (Attems 1909b; Lawrence 1936, 1938, 1955; Lewis 1968); Kuruman (Lewis 1969b); Steinkopf (Attems 1909b). *Western Cape*; Karoo (Attems 1907a); Cape of Good Hope (Kohlrausch 1881, Brölemann 1904a), but Lawrence (1936, 1938, 1955) stated that *S. morsitans* was absent from the Cape Peninsula, an opinion that we accept. *Province(s) Unknown*; Deelfontein,* Schoonard Rydenburg* (Lewis 1969b). SUDAN (Attems 1910b, Schileyko 2002, occurrences mapped by Lewis (1985, map 1]): Northern and southern Sudan (Lewis 1969b). *Bahr el Ghazal*; Rumbek (Lewis 1966); Yirol (Lewis 1967, 1968). *Central*; Disa Forest Res. nr. Roseires (Lewis 1966, 1967). *Darfur*; Kulme (Lewis 1967). *Equatoria*; Gondokoro (Attems 1910a, Lewis 1967). *Khartoum*; Khartoum (Lewis 1965, 1966, 1967, 1968, 1969b, 1984). *Kordofan*; Abu Gubeiha, Rashad (Lewis 1966, 1967). *Upper Nile*; Gabt-el-Maghadid (Flower 1900; Lewis 1967, 1968); Ghrab el Aish (Attems 1909c, Lewis 1967); Malakal, Paloich (Lewis 1966, 1967, 1968). *Province Unknown*; Khar Attar* (Attems 1910b, Lewis 1967). TANZANIA: "Tanganyika" (Brölemann 1904a, Kraus 1958b, Lewis 1969b). "West Tanganyika" (Attems 1930b). *Kilimanjaro*; Mt. Kilimanjaro (Attems 1896); Ngorongoro Crater (Brölemann 1904a). *Morogoro*; Morogoro (Lawrence 1953). *Mwanza*; Mwanza (Attems 1937). *Pwani*; Bagamoyo (Attems 1896, Lawrence 1953); Dar-es-Salaam (Dobroruka 1968, Lawrence 1953). *Rukwa*; Nyonga (Attems 1930b, 1937). *Tanga*; Tanga (Attems 1909e); Usambara Mts. (Attems 1909c). *Pemba I.*; Chake Chake (Attems 1910b). *Fundu I. (near Pemba)* (Attems 1910b). *Zanzibar I.*; Zanzibar (Kohlrausch 1881, Attems 1896, Brölemann 1904a, Lewis 1969). *Province unknown*; Mangasini* (Lawrence 1953). TUNISIA (Brölemann 1921): Tunis (Attems 1902, 1930a; Kraepelin 1903; Brölemann 1904a; Lewis 1969b, 1984); Makthar region* (Dobroruka 1968). UGANDA (Manfredi 1941); Katongo (Kraus 1958a). ZAMBIA (Chamberlin 1927); Kabwe, Kafwi (Kraus 1958a); Lochinvar Nat. Pk. (Dobroruka 1968); Ngwezi Station* (Dobroruka 1969); Victoria Falls (Lewis 2001b). ZIMBABWE (RHODESIA) (Chamberlin 1927, Lewis 1969b); Masvingo (Fort Victoria), Gweru (Gwelo), Mica Hills near Hwange (Wankie) (Lawrence 1936); Mutare (Umtali) (Lewis 1969b); Bulawayo (Lewis 2001b); Great Zimbabwe Nat. Mon. (Great Zimbabwe Ruins), nr. Masvingo and Lake Mutirikwi Rec. Pk. (Lewis 2001b). UNKNOWN COUNTRY: Schumbala-Tal* (Attems 1909c).

ARABIAN PENINSULA

OMAN: Salalah (Lewis 1996). SYRIA (Brölemann 1904a). YEMEN: Aden vicinity (Lewis 1996); Shaykh Uthman (Lewis and Wranik 1990).



Fig. 4. Occurrences of *S. morsitans* in Africa, the Middle East, Europe, and the eastern Atlantic and western Indian Oceans. Question marks, dubious records, likely misidentifications or isolated, transient importations; lines and other symbols as in Fig. 2. Nigeria and Madagascar are shaded to reflect occurrences throughout these countries. Records in the Atlantic Ocean (north to south): general record from the Canary Islands; São Vicente, Cape Verde Islands; and St. Helena. Indian Ocean records (north to south): general record from the Seychelles; Njazidja and Nzwani, Comoro Islands (between Mozambique and Madagascar); and, east of Madagascar, Reunion, Mauritius, and Rodrigues and associated islands.

ASIA (including Indonesia, New Guinea, Philippines, Taiwan, and Japan): ASIA IN GENERAL (Chagas 2000). "HIMALAYA" IN GENERAL (Kohlrausch 1881), not plotted in fig. 5. BANGLADESH (Pocock 1892, Khanna 2001): Ganges R. (Brölemann 1904a). BRUNEI (Würmli 1975). CAMBODIA: South Cambodia (Würmli 1975). CHINA (Newport 1845, 1856; Kohlrausch 1881; Kraepelin 1903; D. Wang and Mauriès 1996): *Beijing*; Beijing (D. Wang and Mauriès 1996). *Yunnan*: Jinshui Co. nr. Yan Dong (cave) (Lewis 2001a). Hong Kong (Kohlrausch 1881, Würmli 1975). INDIA (Linnaeus 1758): *All Provinces except West Bengal* (Khanna 2001 and references therein; Indian records also cited by Kohlrausch (1881), Jangi (1959), Lewis (1966)). *West Bengal*; Calcutta (Würmli 1975). *Andaman and Nicobar Islands* (Khanna 2001). INDONESIA: *Amboina* (believed to refer to Ambon Island and other islands in the Molucca Sea [the "Moluccas"]) (Silvestri 1894, Chamberlin 1920, Würmli 1975). *Ambon* (Attems 1927). *Aru Islands* (Attems 1915); Aru I. (Attems 1914); Trangan I. (Chamberlin 1920). *Bali*; Singaraja (Attems 1932); Pafdangbai* (Lewis 2001b). *Borneo* (Würmli 1975); Banjarmasin (Würmli 1975); Wa Katin* (Attems 1927). *Flores* (Attems 1914); Ende, Maumere, Sikka (Pocock 1894, Chamberlin 1920). *Halmahera* (Chamberlin 1920); Bruiyn* (Silvestri 1894); Patani, Soah Konorah* (Attems 1897). *Irian Jaya (Dutch New Guinea)* (Chamberlin 1914b, 1920, 1944a). *Java* (C. L. Koch 1847, 1863; Daday 1889; Brölemann 1904a; Attems 1914; Würmli 1975); Batavia Bay,* Purmerend* (Chamberlin 1939, 1944b); Bogor (Buitenzorg) (Chamberlin 1914b); Labuhan (Attems 1909). *Kei*

Islands (Silvestri 1894; Attems 1914, 1915, 1927; Chamberlin 1920); Grand-Kei* (between Warka* and Waor*) (Ribaut 1912); Petit-Kei,* Langgur* (Ribaut 1912). *Kepulauan Banda* (Chamberlin 1920). *Lombok*; Ekas Bai, Selong, Swela (Attems 1930d). *New Guinea in general (uncertain whether Irian Jaya [Dutch New Guinea] or Papua New Guinea)* (Haase 1887, Silvestri 1894, Attems 1915). *Nias*; Lelemboli* (Silvestri 1895b). *Nila* (Attems 1927). *Nusa Penida* (nr. Bali) (Lewis 2001b). *Selayar* (Pocock 1894, Attems 1914, Chamberlin 1920). *Sulawesi* (Attems 1914, Würmli 1975); Tempe (Pocock 1894). *Sumatra* (Daday 1889); Atjeh (Attems 1932); Padang (Würmli 1975). *Sumba* (Würmli 1972). *Sumbawa*; Sumbawa Besar, Wawo (Attems 1930d). *Terangan*,* Ngaiguli* (Ribaut 1912). *Ternate* (Attems 1897, Chamberlin 1920). *Teun* (Attems 1927). *Timor* (Chamberlin 1920). **IRAN**: Takht-e-Soleyman Peak, Elburz Mountains (Silvestri 1935). **JAPAN** (Wood 1862, Chamberlin and Wang 1952): Ryu Kyu Islands (Attems 1914, Würmli 1975); Okinawa (Pocock 1895b). **LAOS**: Luang Prabang Mts. (Brölemann 1904a, Attems 1938); Savannakhet (Attems 1938). **MALAYSIA** (Brölemann 1909): Bukit Kuching, Perlis (Verhoeff 1937). *Sarawak*; Baram River (Attems 1897). **MYANMAR** (Pocock 1892, Attems 1914): Arakan, Yoma (Würmli 1975); Bhamo (Brölemann 1904a); Yangon (Rangoon) (Kohlrausch 1881). **PAKISTAN**: Karachi (Brölemann 1904a). **PHILIPPINES** (Attems 1914, Y. Wang 1955a): Luzon; Alabang (nr. Manilla) (Y. Wang 1962); Manila (Brölemann 1904a, Würmli 1975). *Mindanao* (Y. Wang 1951, 1962). *Mindoro* (Brölemann 1904a). *Panay* (Y. Wang 1951, 1962). **SINGAPORE** (Kohlrausch 1881, Brölemann 1904a). **SRI LANKA** (Kohlrausch 1881, Pocock 1892, Brölemann 1904a): Kandy (Würmli 1975). **TAIWAN** (Takakuwa 1940a, b; Y. Wang 1955a; Mitsuo 1993; Chao and Chang 2003): Chanhua (Y. Wang 1955b); Hualien (Y. Wang 1956); Kaosuing (Takao), Kagi,* Yantempo* (Würmli 1975); Chi-Hsi Tseng,* Chi-Kuo Siang,* Chia-Yi Hsien* (Y. Wang 1955b). *Lan Yu Islets* (Y. Wang 1955a). *Jinmen Dao I. (Quemoy)* (Y. Wang 1963). **THAILAND** (Kohlrausch 1881, Daday 1889, Brölemann 1904a): Krung Thep (Bangkok) (Brölemann 1904a). **VIETNAM**: *Nin Thung*, 17 km W Phan Rang (Schileyko 1995); *Kohinhina or Nam-bo* (Schileyko 1992); Annam Mts., Haiphong, Hanoi, Ho Chi Minh City (Saigon), Tonkin (Brölemann 1904a); Buon Me Thuot, Nha Trang, Ninh Hoa, Vinh (Attems 1938); Ca Mau, Da Lat (Attems 1953). *Fai Tsi Long Archipelago*: Dongkko I. (Schileyko 1995). **SOUTH CHINA SEA ISLANDS**: TIZARD BANK (Attems 1953).

INDIAN OCEAN ISLANDS: **COMORO ISLANDS**: *Njazidja (Grande Comore)* (Brölemann 1904a). *Nzwani (Anjouan)* (Attems 1910b). **MADAGASCAR** (Kohlrausch 1881): Lac Ihotray, Itampolo,* Mahafaly,* Miary* (Demange 1969); Antananarivo (Tananarive) (Brölemann 1922); Ankazoabo, Antsiranana (on Baie de Diégo Suarez), Maevatanana, Morondava, Tamatave, Tulléar* vic. (Brölemann 1904a); Behara (Brölemann 1904a, Lawrence 1960); Tuléar (Brölemann 1904a, Lawrence 1960); Fiherenana, Soalala, Tsimanampetsotsa, Andrahomana,* Sambirano-Mahilaka* (Lawrence 1960). **MASCARENE ISLANDS**: *Île Cocos* (beside Rodrigues) (Lewis and Daszak 1996; Lewis 2002, 2003). *Île aux Sables* (beside Rodrigues) (Lewis 2002). *Mauritius (Île de France)* (Brölemann 1904a); Black River Aviaries, Pigeon Wood, Tamarin (Lewis 2002); Cape Malheureux, Petite Rivière (Verhoeff 1939, Lewis 2002). *Rodrigues* (Brölemann 1909, Lewis 2003); hill west of Port Mathurin (Lewis 2002). *Réunion* (Brölemann 1904a). **SEYCHELLES** (Schileyko 1995).

AUSTRALIA AND NEW ZEALAND: **AUSTRALIA**: Capital Territory and all states except Tasmania and, essentially, Victoria (new records, published localities, and associated references summarized by L. E. Koch [1983]). **NEW ZEALAND** (Daday 1889, Würmli 1975), but L. E. Koch (1983) stated that *S. morsitans* is absent from this country, an opinion that we accept.

PACIFIC ISLANDS (new records, published localities, and associated references summarized by Shelley 2004b): **COOK ISLANDS**, **FEDERATED STATES OF MICRONESIA**, **FIJI**, **FRENCH POLYNESIA**, **GUAM**, **KIRIBATI**, **NEW CALEDONIA**, **NORTHERN MARIANNA ISLANDS**, **PAPUA NEW GUINEA** (BOUGAINVILLE), **REPUBLIC OF THE MARSHALL ISLANDS**, **SOLOMON ISLANDS**, **TONGA**, **TUVALU**, **WESTERN SAMOA**. Additionally, Ribaut (1923) cited *S. morsitans* from Koné, New Caledonia, in a reference that Shelley (2004b) did not have access to.

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Fig. 5. Occurrences of *S. morsitans* in Asia, Australia, the Indian Ocean, and the western Pacific Ocean. Lines and symbols as in Figs. 2, 4. All of India and Taiwan, and most of continental Australia, are shaded to reflect occurrences throughout these areas.

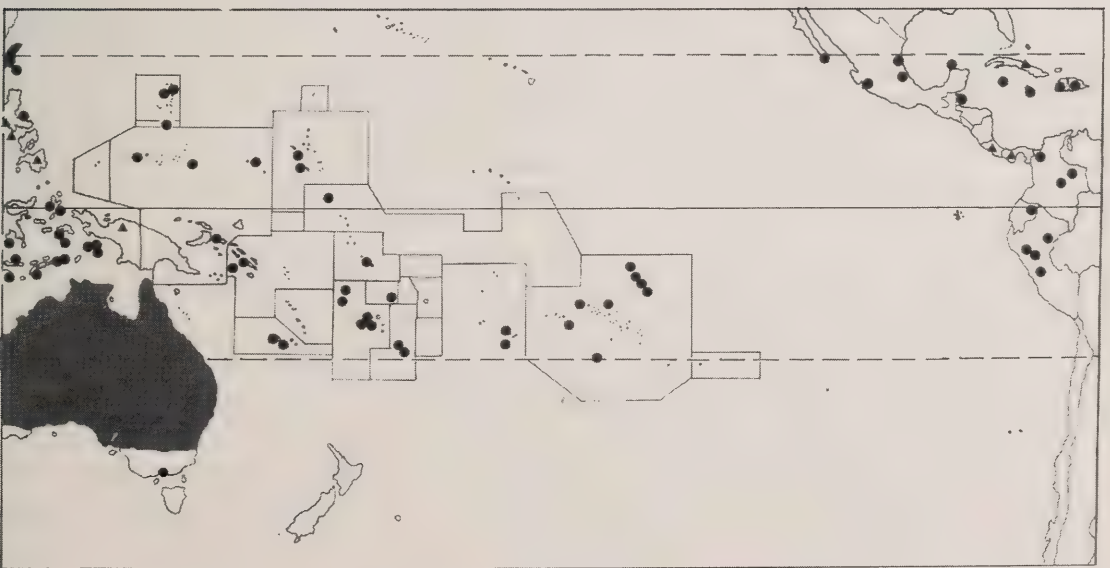


Fig. 6. Occurrences of *S. morsitans* in Asia, Australia, and Pacific Islands. Lines and symbols as in Figs. 2, 4. Most of continental Australia is shaded to reflect widespread occurrence throughout this area.

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BOOK REVIEW

SPIDERS. Seymour Simon. 2003. HarperCollins. 32 pp. ISBN 0-06-028391-2. US\$15.99.

“Spiders are not the most popular kind of animal,” acknowledges Seymour Simon as he calmly introduces a creature many children prefer not to meet. Fantastic photos of amazing clarity, including an artificially colored scanning electron micrograph, capture the varied spider world in this cleanly designed book. There are spiders that live under water in bubbles of air, hairy tarantulas, hundreds of just-hatched spiderlings, and a black widow—red hourglass vivid against its black abdomen. Readers will find colorful crab spiders, wolf spiders, and orb weavers. There are moths and even a hummingbird caught in webs, and a close-up of ribbons of glistening silk emerging from a spider’s spinnerets.

Simon’s understated prose conveys plenty of information in the child-friendly language he honed in his years as a teacher and as a writer for Scholastic magazines. The text accompanying a stop-action photo of a spider in mid-leap reads, “A jumping spider can leap a distance about 40 times the length of its own body. That would be like you jumping the length of two basketball courts and making a slam dunk.”

With the all-important lesson on how to tell spiders from insects, readers will be well equipped to correct hapless family members referring to spiders as “bugs.” Kids should enjoy sharing the many interesting facts with their friends. For example, tarantulas may live 20 years. Black widows are 15 times more poisonous than rattlesnakes. Spiders can make seven different kinds of silk. Some spiders disguise themselves as bird droppings.

The stunning photos are not labeled with scientific or common names, or any captions at all, and while it is sometimes obvious from the text what is going on in the photo, often it is less apparent. It is disappointing not to be able to put a name with the spider in the cover photo—looking to the uninitiated like a leggy cactus bristling with spines. Surely the names could have been provided at the back, if not in captions. Experts will be able to identify spiders to genus (e.g. *Argiope*) or to family (e.g. Thomisidae, Salticidae, Lycosidae, and Aranidae).

Simon wisely observes, “Most of us can become less frightened of spiders just by watching and learning more about them.” This beautiful book, from an award-winning author of 200 nonfiction books for children, is a welcome step in that direction. For ages 5 to 9.

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RECENTLY PUBLISHED BOOKS BRIEFLY NOTED

Jorge A. Santiago-Blay¹

Foundations of Biogeography. Classic papers with commentaries 2004 by M. Lomolino, M. V., D. F. Sax, and J. H. Brown. University of Chicago Press. Chicago, Illinois, U.S.A. 1291 pp.

Colossal tome on must-read papers in biogeography. Cuts across the discipline in numerous important axes, including history of biogeography, the distribution of living things explained (vacariance or dispersal), influence of phylogenetics in biogeography, speciation, island biogeography, assembly rules, and the tropical biodiversity. The breadth of coverage and the abundance of examples from numerous types of organisms, including insects, make this gargantuan publication invaluable. My only concern is a practical one: I am not sure how long the binding will resist regular use.

Fossil Plants 2004 by P. Kendrick and P. Davis Smithsonian Books, Washington [District of Columbia, U.S.A.] in association with the Natural History Museum, London [England, United Kingdom].

This is a succinct compendium of introductory paleobotany, which will be of great interest to readers wanting to become familiarized with ancient plants efficiently. *Fossil Plants* also includes a section on animal-plant interactions.

Dragonflies and damselflies of northeast Ohio 2002 by L. Rosche. Illustrated by J. Haley, J. Brumfield, and K. Metcalf. The Cleveland Museum of Natural History. Cleveland, Ohio, U.S.A. 94 pp.

Colorful and easy-to-use contribution on the imagoes of the Odonata from north-eastern Ohio. This area of the U.S.A. is home to one of its largest metropolitan regions, the greater Cleveland metropolitan area, as well as to some exceedingly beautiful gardens, such as the Holden Arboretum (<http://www.holdenarb.org/>, Kirtland, Lake County, Ohio). Plenty of freshwater habitats present in this mix of urban development and nature will make readers find joy trying to identify local dragonfly and damselfly imagoes. Remarks on the habitat as field recognition traits, including those of newly emerged adults as well as mature specimens are also provided.

Plants in Print. The Age of Botanical Discovery 2004 Collaboration between the United States Botanical Garden and the Chicago Botanic Garden. Washington, District of Columbia, U.S.A. 37 pp.

This is a beautiful, well-illustrated introduction to the early history of botany in the western world.

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BOOK REVIEW

BRINGING FOSSILS TO LIFE, AN INTRODUCTION TO PALEOBIOLOGY (Second Edition) 2004 by Donald R. Prothero. The McGraw-Hill Companies, Inc. New York, NY, U.S.A. 504 pp. ISBN: 0-07-366170-8. Paperback.

This book review reflects three values I treasure: 1) our publications can always be improved, 2) readers of such publications may benefit from research-based pedagogical principles, regardless of their academic standing, and 3) these goals can sometimes be accomplished within budget. *Bringing fossils to life, an introduction to paleobiology*, uses a traditional arrangement in the presentation of what we infer from life in the past. This approach discusses principles of biology and geology and tightly weaves them with paleobiodiversity: the identity, functional morphology, ecology, phylogeny, etc. of the actors and actresses in the drama of ancient life.

The first section, "The fossil record, a window to the past" (chapters 1-10), discusses principles of biology and geology. Chapter 1 summarizes the history of paleobiology. The contributions of Steno, father of stratigraphy, Scheuchzer, maligned by his incorrect interpretation of a giant salamander — which he called *Homo diluvii testis* (human who witnessed the deluge) are followed by a generalized schema and a consideration of fossilization showing how unlikely it is for organisms to become part of the record. A discussion on species and speciation (chapter 3) is included (see Coyne and Orr 2004 *Speciation* as well as West-Eberhard 2003 *Developmental plasticity and evolution* for recent discussions). Systematics (chapter 4) includes the major schools, phenetics and cladistics, which at times had "great similarities to religious movements..." (Hull 1988 *Science as a Process*). Prothero does not shy away from presenting equations and graphical interpretations of allometric growth in his treatment of variation and its causes (chapter 2), functional morphology (chapter 7), and paleoecology (chapter 8). Evolution (chapter 5) and extinction (chapter 6) are aptly sprinkled with models and experimental approaches. Readers are well-warned against trying to infer paleoecological phenomena in as much detail as neoecological ones. Nevertheless, we should be grateful that we can enjoy the broad brushes and occasional fine details that paleoecology, biogeography (chapter 9), and biostratigraphy (chapter 10) offer us.

The second section, "Life of the past and present" (chapters 11-19), introduces major protistan and animal phyla. Relatively little-known organisms, such as the archaeocyathans (perhaps sponge-like creatures, major reef builders during the Early to Middle Cambrian, approx. 530 to 515 million years ago, Ma) are discussed along with better known ones in the fossil record, such as mollusks and echinoderms. For each major group, the morphology, biology, and time range are included. Readers will note that "major" groups do not appear all at the same time, as some creationists argue. Regrettably, only a few pages are devoted to fossil insects (pp. 276-278, see Rasnitsyn 2002 *History of Insects*) and plants (chapter 19); fungi are not discussed. A glossary and a bibliography complete this volume.

The author may want to consider some of the following additional suggestions for future editions concerning content: 1) having a more inclusive taxonomic treatment; 2) improving the layout of some illustrations and replacing others, 3) updating and expanding the "For further reading" and "Biography" sections, as well as 4) making the Index more comprehensive. Furthermore, I believe it is important for a textbook of this type to explicitly confront 'Intelligent Design,' 'creationism' and other anti-evolutionary notions prevalent in the popular culture, by presenting a point by point analysis of the nature of science and the success of each model in predicting and explaining the fossil record [e.g. Delis, *York Daily Record – Sunday News* (Pennsylvania, USA) 13 February 2005, p. B3] Dalmryple 1994 *The age of the Earth*), mode of evolutionary change (e.g. Berra 1990 *Evolution and the myth of creationism*, Futuyma 1995 *Science on trial, the case for evolution* and Pigliucci 2002 *Denying evolution, creationism, scientism, and the nature of nature of science*)]. This is essential given that "30-40% of college students in public universities in several states held Young Earth Creationist beliefs" (<http://serc.carleton.edu/introgeo/earthhistory/creation.html>). Pedagogically, *Bringing fossils to life, an introduction to paleobiology* will benefit from: 1) laying out learning objectives, 2) incorporating activities to encourage the development of problem-solving and general academic skills (e.g. exercises on classification), and 3) using electronic resources (see textbooks by Cunningham et al. 2005 *Environmental Sciences, a global concern*, for an example of this approach).

There are a few recent, college-level, general paleobiology textbooks written in English; *Bringing fossils to life, an introduction to paleobiology*, is a good one. Materials from broad spatiotemporal and taxonomic spectra, with emphasis on animals, are presented in an organized and succinct fashion. Used in conjunction with sources containing a stronger historical approach to paleobiology [e.g. Palmer *Fossil revolution, the finds that changed our views of the past*, see *Entomological News* 115(2): back cover, for a review], supplementary articles written by specialists in different subdisciplines, and additional information on other taxa, beginning students will get a well-rounded introduction to paleobiology.

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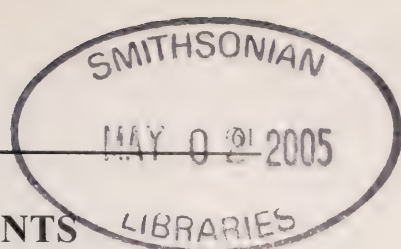
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A PRELIMINARY LIST OF THE ANTS (HYMENOPTERA: FORMICIDAE) OF ALABAMA, U.S.A.¹

Joe A. MacGown² and Jason A. Forster³

ABSTRACT: One hundred and fifty-four species of Formicidae, plus the hybrid fire ant *Solenopsis invicta* x *richteri*, are reported from Alabama, U.S.A. Fifty-nine new state records are presented and county distributions are given for each species.

KEYWORDS: Hymenoptera, Formicidae, Alabama, U.S.A., ants, new records

Although the formicid fauna of North America is relatively well known, distributional records are incomplete for many parts of the United States, including Alabama. The lack of published information on Alabama ants is unfortunate because the state is extremely diverse with five major and 31 minor physiographic regions (Department of Geography, University of Alabama, http://alabama.mamaps.ua.edu/alabama/physical/al_physio.jpg), and one would expect Alabama's ant fauna to reflect this diversity. Several physiographic regions from the northern, southern, and midwestern United States reach their geographic limits in Alabama, forming a unique transitional area that is very important for delimiting the distribution of many species of ants.

L. C. Murphree (1947) conducted a limited survey of ants in Alabama with the results eventually given in his thesis. Murphree did not mention the years that his collections were made, but Glancey et al. (1976) stated that Murphree's work must have been done in the early to mid 1930s when he was scouting the state for the Argentine ant, *Linepithema humile* (Mayr). Most of Murphree's ant collections were from urban habitats; consequently, he listed only 47 species of ants, some of which were later synonymized. Murphree had no unusual species records for Alabama in his list, nor were his identifications considered to be questionable because they were corroborated by the well-known ant taxonomist M. R. Smith. However, three species on Murphree's list, *Dorymyrmex pyramicus* Roger, *Forelius analis* Andre, and *Camponotus pylartes fraxinicola* M. R. Smith, were not included in this list due to difficulties in those groups or questions about their current validity as species, making it impossible to know with certainty which species he actually had. The only other published list of ants for Alabama included 16 species collected at bait in Mobile County (Glancey et al. 1976), the identifications of which were verified by W. F. Buren, another well-known myrmecologist.

¹ Received on January 10, 2005. Accepted on February 9, 2005.

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Edward O. Wilson, a native of Alabama, and various colleagues, including W. Brown, collected ants in different locations in the state, but their records were not compiled into a state list. Rather, records of their specimens and others have been reported in revisional works by various authors including Baroni Urbani and De Andrade (2003), Bolton (2000), Creighton (1930, 1950), Deyrup and Cover (2004), DuBois and Davis (1998), Johnson (1988), MacKay (1993), Shoemaker et al. (1994), D. R. Smith (1979), M. R. Smith (1931, 1932, 1942), Pass (1960), Snelling (1988, 1995), Trager (1984, 1988), Trager et al. (2005), Umphrey (1996), Ward (1985), Watkins (1985), and Wilson (1950, 1952, 2003).

While these authors made significant contributions to the number of species recorded from Alabama, a considerable number of species likely to occur in the state were still not reported. With taxonomic changes taken into account, only 95 species have actually been listed as occurring in Alabama. The list presented here adds 59 new records and increases the list of Alabama ants to 154 species (plus the hybrid fire ant, *Solenopsis invicta x richteri*) representing 37 genera and 8 subfamilies. Efforts were made to sample as many of the diverse habitat types in Alabama as possible, and ants were collected or reported from all 67 counties in Alabama (Fig. 1).

Many of the species records included in this list are based on collections made during the last 12 years, with 125 species and all of the 59 new state records collected during this time period. The remaining species records are from examination of older specimens stored at both the Auburn University Entomological Museum (AUEM) in Alabama and the Mississippi Entomological Museum (MEM) at Mississippi State University, as well as from literature records.

Preliminary List of the Formicidae of Alabama, U.S.A.

The list presented is arranged by subfamily, tribe, and genus according to Bolton (2003). Names follow Bolton (1995), except *Dorymyrmex*, which follows Snelling (1995); *Pyramica*, which follows Bolton (2000); *Aphaenogaster*, which follows Umphrey (1996); *Pheidole*, which follows Wilson (2003); and *Crematogaster*, which follows Johnson (1988) and Deyrup (2003).

County records are provided with counties of material examined by the authors given first (AUEM and/or MEM indicate deposition of specimens), followed by literature records. Only unique county records are listed for literature records, with duplicate counties excluded if specimens from those counties were in the AUEM or MEM collections. New records of species for Alabama are indicated by an asterisk (*).

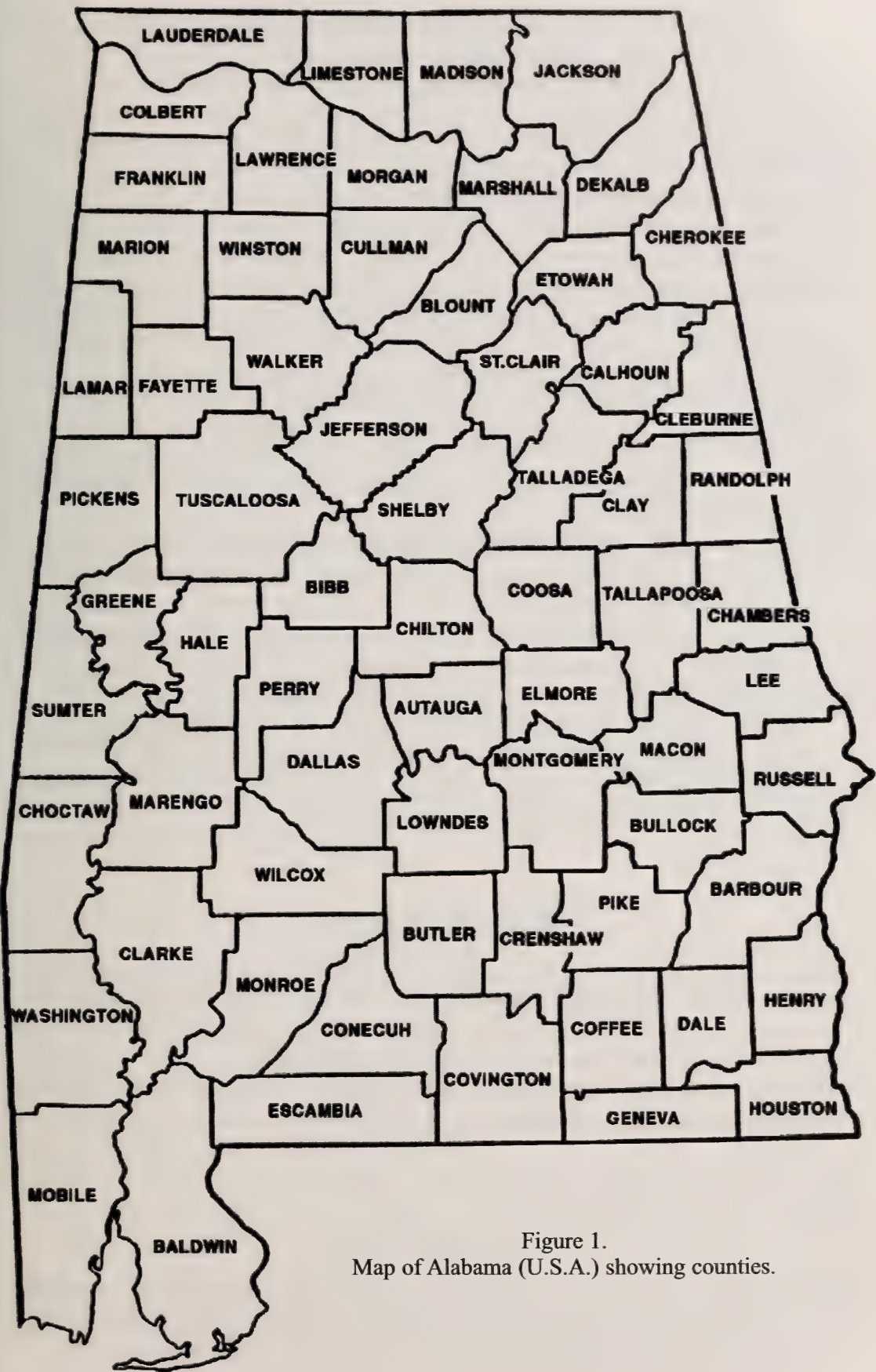


Figure 1.
Map of Alabama (U.S.A.) showing counties.

Family Formicidae
Subfamily Dolichoderinae
Tribe Dolichoderini

Dolichoderus mariae **Forel**. No county given (MacKay 1993).

Dolichoderus plagiatus* (Mayr**). DeKalb Co. (AUEM, MEM).

Dolichoderus pustulatus **Mayr**. No county given (MacKay 1993).

Dolichoderus taschenbergi (**Mayr**). No county given (MacKay 1993).

Dorymyrmex bureni* (Trager**). Bibb, Blount, Clarke, Coffee, Covington, Dallas, Escambia, Geneva, Hale, Houston, Lamar, Lee, Lowndes, Macon, Marengo, Monroe, Perry, Russell, Sumter, Tuscaloosa, and Wilcox Cos. (AUEM, MEM).

Dorymyrmex flavus* **McCook. Baldwin, Conecuh, and Mobile Cos. (AUEM, MEM).

Dorymyrmex grandulus (**Forel**). Mobile Co. (Trager 1988).

Dorymyrmex smithi* **Cole. Baldwin, Geneva, Lee, Macon, and Mobile Cos. (AUEM, MEM).

Forelius **sp.** Baldwin, Bibb, Blount, Butler, Clay, Cleburne, Colbert, Cullman, Dallas, Fayette, Jackson, Lamar, Lawrence, Lee, Limestone, Lowndes, Macon, Marion, Mobile, Morgan, Pickens, Russell, Tuscaloosa, Walker, and Winston Cos. (AUEM, MEM). There could be two or more species involved in this group and further study is needed.

Linepithema humile (**Mayr**). Baldwin, Bibb, Coffee, Conecuh, Covington, Dallas, Greene, Lowndes, Marengo, Mobile, Monroe, Shelby, Tuscaloosa, Walker, Washington, Wilcox, and Winston Cos. (AUEM, MEM).

Tapinoma sessile (**Say**). DeKalb, Etowah, Lauderdale, Lawrence, Limestone, Macon, and Tuscaloosa Cos. (AUEM, MEM).

Subfamily Formicinae
Tribe Lasiini

Lasius alienus* (Foerster**). Barbour, Bibb, Butler, Jackson, Lauderdale, Lawrence, Macon, Madison, Marion, Monroe, and Morgan Cos. (AUEM, MEM).

Lasius flavus (**Fabricius**). No county given. (Smith 1979).

Lasius neoniger* **Emery. Limestone and Madison Cos. (AUEM).

Lasius umbratus* (Nylander**). Covington, Lawrence, and Macon Cos. (AUEM, MEM).

Tribe Plagiolepidini

Brachymyrmex depilis **Emery**. Baldwin, Bibb, Clay, Conecuh, Dallas, DeKalb, Escambia, Jackson, Macon, Monroe, Pickens, Tuscaloosa, and Winston Cos. (AUEM, MEM); Mobile Co. (Murphree 1947).

- **Brachymyrmex musculus* **Forel**. Baldwin, Bibb, Butler, Choctaw, Clarke, Coffee, Conecuh, Covington, Dale, Dallas, Escambia, Geneva, Houston, Lee, Lowndes, Macon, Marengo, Marion, Mobile, Monroe, Montgomery, Shelby, Sumter, Tuscaloosa, Washington, and Wilcox. (AUEM, MEM).
- **Brachymyrmex* **sp.** Tuscaloosa Co. (MEM). This species is possibly an undescribed new species (Mark Deyrup, pers. comm.), and it is distinctly different from the two other species of *Brachymyrmex* on this list.
- Paratrechina arenivaga* (**Wheeler**). Baldwin, Bibb, Blount, Choctaw, Lee, and Marion Cos. (AUEM, MEM).
- Paratrechina bourbonica* (**Forel**). Bibb Co. (MEM); Mobile Co. (Trager 1984).
- Paratrechina concinna* **Trager**. No county given (Trager 1984).
- Paratrechina faisonensis* (**Forel**). Bibb, Blount, Butler, Calhoun, Clay, Cleburne, Colbert, Conecuh, Covington, Dallas, DeKalb, Escambia, Franklin, Greene, Lamar, Lauderdale, Lawrence, Lee, Lowndes, Macon, Madison, Mobile, Perry, Shelby, Sumter, Tallapoosa, Tuscaloosa, Wilcox, and Winston Cos. (AUEM, MEM).
- Paratrechina longicornis* (**Latreille**). Widespread, according to Murphree (1947). Trager (1984) stated that this species was present in the Gulf States, but did not give more specific distributional information.
- **Paratrechina parvula* (**Mayr**). Bibb, DeKalb, and Russell Cos. (AUEM, MEM).
- **Paratrechina phastasma* **Trager**. Baldwin Co. (MEM).
- Paratrechina vividula* (**Nylander**). Baldwin, Bibb, Calhoun, Cherokee, Dallas, Fayette, Franklin, Hale, Lawrence, Lee, Limestone, Lowndes, Marion, Montgomery, Morgan, Sumter, and Wilcox Cos. (AUEM, MEM).
- Paratrechina wojciki* **Trager**. Mobile Co. (Trager 1984).
- Prenolepis imparis* (**Say**). Bibb, Chambers, Clay, DeKalb, Lauderdale, Lawrence, Lee, Macon, Morgan, Sumter, Talladega, Tallapoosa, and Winston Cos. (AUEM, MEM).

Tribe Camponotini

- **Camponotus americanus* **Mayr**. Calhoun, Clay, Cleburne, Coffee, Colbert, Cullman, DeKalb, Etowah, Lawrence, Lee, Tallapoosa, and Winston Cos. (AUEM, MEM).
- Camponotus caryae* (**Fitch**). Jefferson Co. (Murphree 1947).
- **Camponotus castaneus* (**Latreille**). Baldwin, Bibb, Covington, Henry, Lawrence, Lee, Limestone, Lowndes, Macon, Mobile, Monroe, Morgan, Shelby, and Wilcox Cos. (AUEM, MEM).
- Camponotus chromaiodes* **Bolton**. Butler, Calhoun, Clarke, Colbert, Covington, Dallas, DeKalb, Franklin, Lamar, Lauderdale, Lawrence, Lee, Lowndes, Macon, Madison, Marengo, Marion, Sumter, and Winston Cos. (AUEM, MEM).
- Camponotus decipiens* **Emery**. Clay, Fayette, Lee, Limestone, Lowndes, Madison, and Marengo Cos. (AUEM, MEM); Autauga and St. Clair Cos. (Murphree 1947).

- Camponotus discolor* (Buckley). Pickens Co. (AUEM); Baldwin Co. (Murphree 1947).
- **Camponotus floridanus* (Buckley). Baldwin, Geneva, Mobile, and Tallapoosa Cos. (AUEM, MEM).
- **Camponotus impressus* (Roger). Baldwin, Barbour, Bibb, Dallas, Lee, Lowndes, and Marengo. (AUEM, MEM).
- **Camponotus mississippiensis* M. R. Smith. Lawrence and Lowndes Cos. (AUEM, MEM).
- **Camponotus nearcticus* Emery. Lauderdale, Lawrence, Lowndes, Morgan, and Shelby Cos. (AUEM, MEM).
- Camponotus obliquus* M. R. Smith. No county given (Smith 1979).
- Camponotus pennsylvanicus* (DeGeer). Bibb, Blount, Cleburne, Dallas, De Kalb, Escambia, Greene, Hale, Lauderdale, Lawrence, Lee, Limestone, Lowndes, Marengo, Monroe, Morgan, Pickens, Shelby, Sumter, Tuscaloosa, and Wilcox Cos. (AUEM, MEM); Mobile Co. (Glancey et al. 1976).
- **Camponotus snellingi* Bolton. Bibb, Colbert, DeKalb, Lawrence, Lee, Hale, Monroe, Tuscaloosa, and Walker Cos. (AUEM, MEM).
- **Camponotus socius* Roger. Baldwin and Mobile Cos. (AUEM, MEM).
- **Camponotus subbarbatus* Emery. Bibb, Lauderdale, Lawrence, Marion, and Tuscaloosa Cos. (AUEM, MEM).

Tribe Formicini

- Formica archboldi* M. R. Smith. No county given (Smith 1979).
- **Formica integra* Nylander. Clay, DeKalb, Etowah, Lee, Morgan, and Randolph Cos. (AUEM, MEM).
- **Formica pallidefulva* Latreille. Clay, Cleburne, DeKalb, Fayette, Lauderdale, Lawrence, Limestone, Macon, Marion, Morgan, and Tuscaloosa Cos. (AUEM, MEM).
- **Formica rubicunda* Emery. DeKalb Co. (MEM).
- Formica schaufussi dolosa* Buren. Bibb, Clay, DeKalb, Lawrence, Lowndes, and Sumter Cos. (AUEM, MEM); Mobile Co. (Glancey et al. 1976).
- **Formica subintegra* Wheeler. Clay Co. (AUEM, MEM).
- **Formica subsericea* Say. Barbour, Bibb, Cherokee, DeKalb, Etowah, Lawrence, Lowndes, Madison, and Shelby Cos. (AUEM, MEM).
- **Formica* n. sp. Bibb, Butler, Lowndes, Sumter, and Tuscaloosa Cos. This is a new species in the *pallidefulva* group being described by Trager (2005, in press).

Subfamily Pseudomyrmecinae Tribe Pseudomyrmecini

- Pseudomyrmex ejectus* (F. Smith). Baldwin, Houston, Lee, and Macon Cos. (AUEM, MEM); Geneva Co. (Murphree 1947); Mobile and Monroe Cos. (Ward 1985).

Pseudomyrmex pallidus (F. Smith). Baldwin, Bibb, Blount, Clarke, Dale, Dallas, Marengo, Montgomery, Shelby, Washington, and Wilcox Cos. (AUEM, MEM); Mobile Co. (Ward 1985).

**Pseudomyrmex seminole* Ward. Baldwin Co. (MEM).

Subfamily Ecitoninae Tribe Ecitonini

Neivamyrmex carolinensis (Emery). Chilton, Choctaw, Etowah, and Pickens Cos. (Smith 1942).

Neivamyrmex nigrescens (Cresson). Calhoun, Cherokee, Cullman, Lauderdale, Lee, and Madison Cos. (AUEM, MEM); Clay, Jefferson, Mobile, and Morgan Cos. (Smith 1942).

Neivamyrmex opacithorax (Emery). No county given (Watkins 1985).

Subfamily Amblyoponinae Tribe Amblyoponini

**Amblyopone pallipes* (Haldeman). Bibb, Lauderdale, Lawrence, and Lee Cos. (AUEM, MEM).

Subfamily Ponerinae Tribe Ponerini

Cryptopone gilva (Roger). Butler Co. (AUEM).

Hypoponera opaciceps (Mayr). Covington and Marengo Cos. (AUEM); Baldwin, Bullock, Conecuh, Crenshaw, Mobile, Montgomery, and Russell Cos. (Murphree 1947).

Hypoponera opacior (Forel). Baldwin, Barbour, Bibb, Blount, Butler, Chambers, Choctaw, Clay, Cleburne, Conecuh, Cullman, Dallas, Escambia, Franklin, Houston, Lauderdale, Lawrence, Lee, Macon, Madison, Marengo, Mobile, Monroe, Montgomery, Morgan, Shelby, Sumter, Tallapoosa, Tuscaloosa, Walker, and Winston Cos. (AUEM, MEM); Elmore Co. (Murphree 1947).

Odontomachus brunneus (Patton). Houston Co. (AUEM); Baldwin and Mobile Cos. (Deyrup and Cover 2004).

**Odontomachus ruginodis* M. R. Smith. Baldwin Co. (MEM).

**Ponera exotica* M. R. Smith. Bibb, Lawrence, and Sumter Cos. (MEM).

**Ponera pennsylvanica* Buckley. Bibb, Blount, Clay, DeKalb, Lawrence, Lee, Macon, Monroe, Sumter, and Tuscaloosa Cos. (AUEM, MEM).

Subfamily Ectatomminae
Tribe Ectatommini

****Gnamptogenys triangularis* (Mayr).** Mobile Co. (Lloyd Davis, Gainesville, FL, pers. comm.).

Subfamily Proceratiinae
Tribe Proceratiini

****Discothyrea testacea* Roger.** Baldwin, Chilton, Lauderdale, Lawrence, and Lee Cos. (AUEM, MEM).

***Proceratium chickasaw* De Andrade.** Bibb, Lauderdale, Lawrence, and Tuscaloosa Cos. (MEM); Mobile Co. (Baroni Urbani and De Andrade 2003).

***Proceratium croceum* (Roger).** Baldwin Co. (MEM); DeKalb, Mobile, Montgomery, and Tuscaloosa Cos. (Baroni Urbani and De Andrade 2003).

***Proceratium pergandei* (Emery).** Lawrence Co. (MEM); Mobile Co. (Baroni Urbani and De Andrade 2003).

***Proceratium silaceum* Roger.** Bibb and Tuscaloosa Cos. (MEM); Baldwin and Mobile Cos. (Baroni Urbani and De Andrade 2003).

Subfamily Myrmicinae
Tribe Dacetini

***Pyramica angulata* (M. R. Smith).** Baldwin, Lauderdale, Lawrence, and Marshall Cos. (AUEM, MEM); Tuscaloosa Co. (Bolton 2000).

***Pyramica clypeata* (Roger).** Morgan Co. (AUEM); Marshall and Tuscaloosa Cos. (Bolton 2000).

***Pyramica creightoni* (M. R. Smith).** Mobile Co. (MEM).

***Pyramica dietrichi* (M. R. Smith).** Lawrence Co. (MEM); Houston, Mobile, and Tuscaloosa Cos. (Bolton 2000).

***Pyramica laevinasis* (M. R. Smith).** Bibb, Lauderdale, and Lee Cos. (AUEM, MEM); Marshall and Mobile Cos. (Bolton 2000).

***Pyramica margaritae* (Forel).** No county given (Smith 1979).

***Pyramica membranifera* (Emery).** Baldwin, Bibb, and Macon Cos. (MEM).

****Pyramica metazytes* Bolton.** Monroe Co. (MEM).

***Pyramica ohioensis* (Kennedy & Schramm).** Clay, Lauderdale, Lawrence, Lee, Monroe, and Sumter Cos. (AUEM, MEM).

***Pyramica ornata* (Mayr).** Baldwin, Bibb, Chilton, Conecuh, Henry, Lauderdale, Lawrence, Lee, Marion, Sumter, and Tuscaloosa Cos. (AUEM, MEM); Marshall Co. (Bolton 2000).

****Pyramica pergandei* (Emery).** DeKalb Co. (AUEM, MEM).

***Pyramica pilinasis* (Forel).** Tuscaloosa Co. (Bolton 2000).

***Pyramica pulchella* (Emery).** Baldwin, Bibb, and Conecuh Cos. (MEM); Marshall, Mobile, and Morgan Cos. (Bolton 2000).

Pyramica reflexa (Wesson & Wesson). Conecuh and Lawrence Cos. (MEM); Franklin Co. (Bolton 2000).

Pyramica rostrata (Emery). Bibb, Clay, Lauderdale, Lawrence, Lee, and Sumter Cos. (AUEM, MEM); Baldwin, Franklin, and Tuscaloosa Cos. (Bolton 2000).

Pyramica talpa (Weber). Baldwin and Bibb Cos. (MEM); Houston and Mobile Cos. (Bolton 2000).

Strumigenys louisianae Roger. Baldwin, Barbour, Bibb, Butler, Clay, Henry, Houston, Lauderdale, Lawrence, Lee, Sumter, and Tuscaloosa Cos. (AUEM, MEM); Morgan Co. (Smith 1932).

Tribe Attini

Cyphomyrmex rimosus (Spinola). Baldwin, Conecuh, Covington, Dale, Escambia, Houston, Lowndes, Mobile, Monroe, Montgomery, and Wilcox Cos. (AUEM, MEM).

**Trachymyrmex septentrionalis* (McCook). Bibb, Butler, Covington, Hale, Houston, Lawrence, Lowndes, Macon, Mobile, Monroe, Pickens, Talladega, Tuscaloosa, and Wilcox Cos. (AUEM, MEM).

Tribe Stenammini

Stenamma foveolocephalum M. R. Smith. Bibb Co. (DuBois and Davis 1998).

**Stenamma meridionale* M. R. Smith. Monroe and Sumter Cos. (MEM).

Tribe Solenopsidini

Monomorium floricola (Jerdon). No county given (Smith 1979).

Monomorium minimum (Buckley). Baldwin, Bibb, Covington, Escambia, Hale, Lauderdale, Lawrence, Lowndes, Marengo, Mobile, Montgomery, Morgan, Pickens, and Tuscaloosa Cos. (AUEM, MEM).

Monomorium pharaonis (Linnaeus). Lamar Co. (AUEM); Widespread, according to Murphree (1947).

Monomorium viride Brown. Mobile Co. (Glancey et al. 1976). This record may be unreliable as workers of this species are difficult to distinguish from *M. minimum*.

**Solenopsis carolinensis* Forel. Cleburne, Colbert, Covington, Henry, Lee, Lowndes, Macon, Madison, Monroe, Pickens, and Tuscaloosa Cos. (AUEM, MEM).

Solenopsis geminata (Fabricius). Mobile Co. (Creighton 1930); Baldwin, Barbour, Bibb, Bullock, Coffee, Covington, Crenshaw, Dale, Escambia, Geneva, Houston, and Pike Cos. (Murphree 1947). This species was not found during the course of recent collecting and is thought to have been displaced from the area by the introduced fire ants, *S. invicta*, *S. richteri*, and their hybrid.

- Solenopsis globularia littoralis* **Creighton**. Mobile Co. (MEM); Baldwin Co. (Creighton 1930); Russell Co. (Murphree 1947).
- Solenopsis invicta* **Buren**. Baldwin, Bibb, Chambers, DeKalb, and Lee Cos. (AUEM, MEM); widespread, especially in southern half of state (Shoemaker et al. 1994).
- Solenopsis invicta x richteri*. Lauderdale and Sumter Cos. (AUEM, MEM); widespread, especially in north-central portion of state (Shoemaker et al. 1994).
- Solenopsis molesta* (Say). Baldwin, Barbour, Bibb, Clay, Franklin, Hale, Houston, Lamar, Lauderdale, Lawrence, Lee, Macon, Marion, Mobile, Morgan, Pickens, Shelby, and Tuscaloosa, Cos. (AUEM, MEM).
- Solenopsis pergandei* **Forel**. Bibb, Covington, Lauderdale, Mobile, and Tuscaloosa Cos. (AUEM, MEM); Coosa Co. (Murphree 1947).
- **Solenopsis picta* **Emery**. Baldwin, Barbour, and Montgomery Cos. (AUEM, MEM).
- Solenopsis richteri* **Forel**. Lawrence Co. (AUEM, MEM); Mobile Co. (Creighton 1930); Baldwin and Mobile Cos.; and Spring Hill and Whistler (counties unknown) (Murphree 1947); widespread, especially in the northwestern portion of Alabama (Shoemaker et al. 1994).
- **Solenopsis tennesseensis* **M. R. Smith**. Baldwin Co. (MEM).
- **Solenopsis tonsa* **Thompson**. Baldwin Co. (MEM).
- Solenopsis xyloni* **McCook**. Lee Co. (AUEM); Madison, Mobile and Montgomery Cos. (Creighton 1930). Historically this species was widespread, occurring in 154 communities in Alabama, according to Murphree (1947). This species was not found during the course of recent collecting and is thought to have been displaced from the area by the introduced fire ants, *S. invicta*, *S. richteri*, and their hybrid.

Tribe Myrmicini

- **Myrmica americana* **Weber**. Jackson Co. (AUEM, MEM).
- **Myrmica pinetorum* **Wheeler**. Barbour, Clay, DeKalb, and Winston Cos. (AUEM).
- **Myrmica punctiventris* **Roger**. Clay, Cleburne, Coosa, DeKalb, Etowah, Lee, Macon, and Monroe Cos. (AUEM, MEM).
- Pogonomyrmex badius* (Latreille). Baldwin, Covington, Lee, and Mobile Cos. (AUEM, MEM); Barbour Co. (Murphree 1947).

Tribe Tetramoriini

- Tetramorium bicarinatum* (Nylander). Mobile Co. (Glancey et al. 1976); widespread, according to Murphree (1947).
- **Tetramorium caespitum* (Linnaeus). Limestone Co. (AUEM).
- Tetramorium lanuginosum* **Mayr**. Dale and Houston Cos. (Murphree 1947).

Tribe Pheidolini

- Aphaenogaster floridana* **M. R. Smith**. No county given (Smith 1979).
- Aphaenogaster fulva* **Roger**. Bibb, Conecuh, Lauderdale, Lawrence, Perry, Sumter, and Tuscaloosa Cos. (AUEM, MEM); Autauga and Colbert Cos. (Murphree 1947).
- **Aphaenogaster lamellidens* **Mayr**. Bibb, Blount, Chambers, Cherokee, Colbert, Fayette, Lauderdale, Lawrence, Lee, Macon, Morgan, and Tuscaloosa Cos. (AUEM, MEM).
- Aphaenogaster miamiana* **Wheeler**. Baldwin, Barbour, Bibb, Butler, Escambia, Geneva, Houston, and Macon Cos. (AUEM, MEM).
- **Aphaenogaster picea* (**Wheeler**). Clay and Franklin Cos. (AUEM, MEM).
- Aphaenogaster rudis* **Enzmann. Cleburne Co.** (Umphrey 1996).
- **Aphaenogaster tennesseensis* (**Mayr**). Bibb and Houston Cos. (AUEM).
- Aphaenogaster treatae* **Forel**. Bibb, Clay, DeKalb, Lawrence, Macon, and Tuscaloosa Cos. (AUEM, MEM); Lamar Co. (Murphree 1947).
- Aphaenogaster* sp. (*fulva-texana-rudis* complex). Baldwin, Bibb, DeKalb, Lauderdale, Lawrence, Sumter, and Tuscaloosa Cos. (AUEM, MEM). This species is probably either *Aphaenogaster carolinensis* Wheeler or A. n. sp. N19 (Umphrey 1996). These two species cannot be separated reliably using morphological characteristics.
- **Pheidole adrianoi* **Naves**. Baldwin Co. (MEM).
- Pheidole bicarinata* **Mayr**. Bibb, Blount, Dallas, DeKalb, Franklin, Geneva, Lauderdale, Lawrence, Lowndes, Macon, Marion, Morgan, Pickens, Shelby, Tuscaloosa, and Winston Cos. (AUEM, MEM).
- Pheidole crassicornis* **Emery**. Barbour, DeKalb, Lee, Lowndes, and Macon Cos. (AUEM, MEM); Butler Co. (Murphree 1947).
- Pheidole davisii* **Wheeler**. No county given (Wilson 2003).
- Pheidole dentata* **Mayr**. Baldwin, Barbour, Bibb, Clay, Cleburne, Colbert, Coosa, Covington, Cullman, Escambia, Franklin, Geneva, Hale, Houston, Lawrence, Lee, Limestone, Lowndes, Macon, Marion, Mobile, Monroe, Perry, Shelby, Tuscaloosa, and Washington Cos. (AUEM, MEM).
- Pheidole dentigula* **M. R. Smith**. Barbour, Bibb, Calhoun, Clay, Henry, Houston, Lawrence, Lee, Marion, Sumter, and Tuscaloosa Cos. (AUEM, MEM).
- Pheidole floridana* **Emery**. Baldwin Co. (MEM); Mobile Co. (Wilson 2003).
- Pheidole metallescens* **Emery**. Barbour, Covington, Mobile, Tuscaloosa, and Wilcox Cos. (AUEM, MEM).
- Pheidole moerens* **Wheeler**. Baldwin, Coffee, Covington, Dale, Geneva, Houston, and Mobile Cos. (AUEM, MEM).
- **Pheidole morrissi* **Forel**. Baldwin, Covington, Escambia, and Madison Cos. (AUEM, MEM).
- Pheidole obscurithorax* **Naves**. Baldwin, Escambia, and Mobile Cos. (AUEM, MEM).
- **Pheidole tetra* **Creighton**. Winston Co. (AUEM).
- **Pheidole tysoni* **Forel**. Clay, Lawrence, Montgomery, and Pickens Cos. (AUEM, MEM).

- **Pheidole* sp. Bibb, Clay, Dallas, Lamar, Lauderdale, Lawrence, Marion, and Tuscaloosa Cos. (AUEM, MEM). This species does not fit Wilson's key to *Pheidole* (2003) and is apparently an undescribed species in the *crassicornis* group.

Tribe Crematogastrini

- Crematogaster ashmeadi* Mayr. Baldwin, Bibb, Blount, Cherokee, Colbert, Covington, Cullman, Dallas, Fayette, Houston, Lauderdale, Lawrence, Lee, Limestone, Lowndes, Madison, Mobile, Monroe, Pickens, Shelby, Talladega, Tuscaloosa, Walker, Wilcox, and Winston Cos. (AUEM, MEM); Henry and Saint Clair Cos. and Edwardsville (county unknown) (Murphree 1947).
- Crematogaster atkinsoni* Wheeler. No county given (Johnson 1988).
- Crematogaster lineolata* (Say). Barbour, Bibb, Blount, Choctaw, Clay, Cleburne, Colbert, Cullman, Dale, Dallas, DeKalb, Escambia, Henry, Lauderdale, Lawrence, Limestone, Lowndes, Macon, Marengo, Russell, Tuscaloosa, and Wilcox Cos. (AUEM, MEM); Chilton Co. (Johnson 1988); Franklin, and Montgomery Cos. (Murphree 1947).
- Crematogaster minutissima* Mayr. Bibb, Lawrence, Lee, Marion, and Mobile Cos. (AUEM, MEM); Pike and Talladega Cos. (Murphree 1947).
- **Crematogaster missuriensis* Emery. Baldwin, Bibb, Clay, Lawrence, Madison, and Morgan Cos. (AUEM, MEM).
- Crematogaster pilosa* Emery. Baldwin, Cleburne, Coffee, Cullman, Dallas, Escambia, Franklin, Jackson, Lauderdale, Lawrence, Lee, Marion, Monroe, Pickens, Shelby, Sumter, Tallapoosa, Tuscaloosa, and Washington Cos. (AUEM, MEM); Calhoun, Cherokee, Conecuh, Dale, Fayette, and Greene Cos. (Murphree 1947).
- **Crematogaster vermiculata* Emery. Barbour and Lauderdale Cos. (AUEM, MEM).

Tribe Formicoxenini

- **Protomognathus americanus* (Emery). Madison Co. (AUEM).
- Temnothorax bradleyi* (Wheeler). Baldwin and Tuscaloosa Cos. (Wilson 1952); Jefferson Co. (Murphree 1947).
- Temnothorax curvispinosus* (Mayr). Clay, Cleburne, DeKalb, Etowah, Lauderdale, Lawrence, Lee, Lowndes, Madison, Marengo, and Winston Cos. (AUEM, MEM).
- Temnothorax longispinosus* (Roger). Clay and DeKalb Cos. (AUEM, MEM).
- **Temnothorax pergandei* (Emery). Cullman, DeKalb, Lawrence and Lowndes Cos. (AUEM, MEM).
- **Temnothorax schaumii* (Roger). Lawrence Co. (AUEM, MEM).
- Temnothorax smithi* (Baroni Urbani). No county given (Smith 1979).
- **Temnothorax texanus* (Wheeler). Clay Co. (AUEM, MEM).
- Temnothorax tuscaloosae* (Wilson). Monroe Co. (MEM); Tuscaloosa Co. (Wilson 1950).

Tribe Myrmecini

***Myrmecina americana* Emery.** Baldwin, Bibb, Chilton, Clay, Dallas, Fayette, Henry, Houston, Jackson, Lauderdale, Lawrence, Lee, Macon, Marion, Shelby, Sumter, and Tuscaloosa Cos. (AUEM, MEM).

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REVIEW OF *PARADORYDIUM* KIRKALDY (HOMOPTERA, AUCHENORRHYNCHA, CICADELLIDAE) FROM TURKEY, WITH THE DESCRIPTION OF A NEW SPECIES¹

Emine Demir²

ABSTRACT: The following species of *Paradorydium* are recorded from Turkey: *P. mustafai* sp.n., *P. occidentale* Lindberg (new record) and *P. paradoxum* (Herrich-Schäffer). Taxonomical features and figures of the species are given.

KEY WORDS: *Paradorydium mustafai*, sp.n., Homoptera, Cicadellidae, Auchenorrhyncha, Turkey

Paradorydium is one of only four genera of the Old World leafhopper tribe Paradorydiini (Linnavuori, 1979). The distinctive elongate shape (Fig. 1) of the members of this tribe has been likened to the seeds of the grasses on which they live. Sixteen species were recorded from Africa by Linnavuori (1979) and ten species from the Palaearctic region by Nast (1972), including *P. paradoxum* Herrich-Schaeffer). In the present work, two other species, *P. occidentale* Lindberg and *P. mustafai* sp. nov., are recorded from Turkey. All three species are described and a key provided for their separation.

Key to the species of *Paradorydium* from Turkey

1. Length of vertex approximately 6.5 X length of pronotum. Aedeagus with a pair of apical processes (Fig. 11).....*mustafai*
- Length of vertex 4-5 X length of pronotum. Aedeagus without apical processes.....2
- 2(1) Aedeagus with a pair of basal processes (Fig. 33)*paradoxum*
- Aedeagus without a pair of basal processes (Fig. 21).....*occidentale*

Paradorydium mustafai sp. n. (Figs. 1-11)

Description: Length: male 8.8 - 9.7 mm, female 11.8 – 12.2 mm. Yellowish-green. Crown and hemelytra with fine brown punctation (only a female with red punctation). Face with distinct dark lateral bands. Veins of forewing brownish-yellow, granulated.

Crown (Figs. 3-4) tetrahedral in cross section, median, lateral and ventral carinae distinct; vertex 6.5 X as long as median length of pronotum, sides concave, apex pointed and curved dorsad, median carina reaching to apex, Hemelytra transparent with sharp apex, enclosing entire abdomen.

Male genitalia as in Figs. 6-11. Side lobes of pygophore insinuate apically. Subgenital plate with apical margin forming an inner process and an outer lobe. Stem of aedeagus elongate, slightly re-curved dorsad, with falcate apical appendages.

Female genitalia as in Fig. 5.

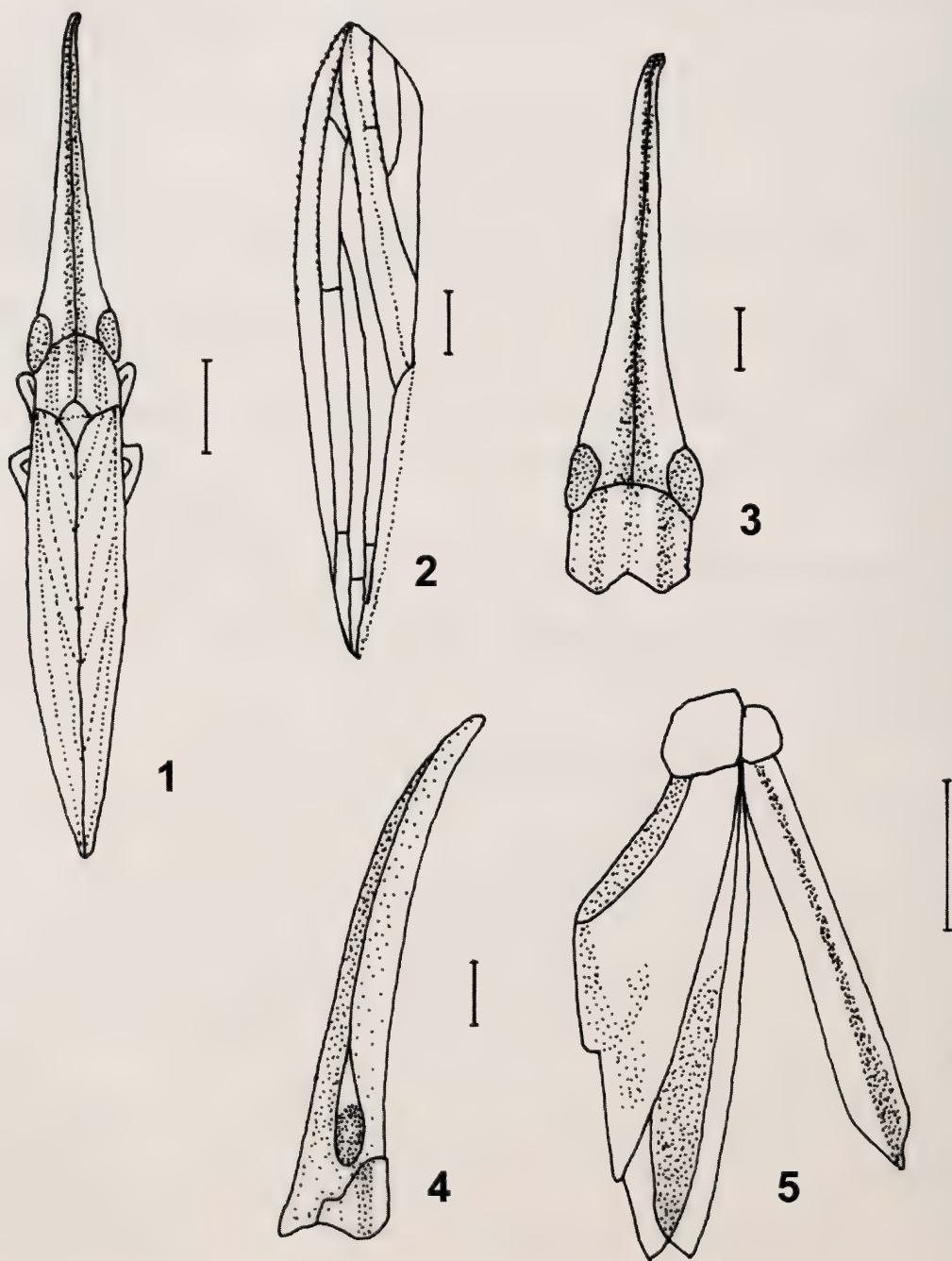
Material Studied: Holotype: male, TURKEY: Southwest Anatolia, Antalya, Manavgat, Hacıobası, 22.06.2002, on *Bothriochloa ischaemum*. Paratypes: 2 males and 3 females, TURKEY, Antalya, Manavgat, Hacıobası, 22.06.2002, on *Bothriochloa ischaemum*, 2 males, Antalya, Manavgat, Örenşehir, 15.10.2001, 8 males and 4 females, Antalya, Manavgat, Hacıobası, 26.08.2003, on *Bothriochloa ischaemum*. Holotype and paratypes are deposited in Centre for Entomological Studies Ankara and 1 male and 1 female in the Natural History Museum, London.

¹ Received on March 10, 2004. Accepted on January 3, 2005.

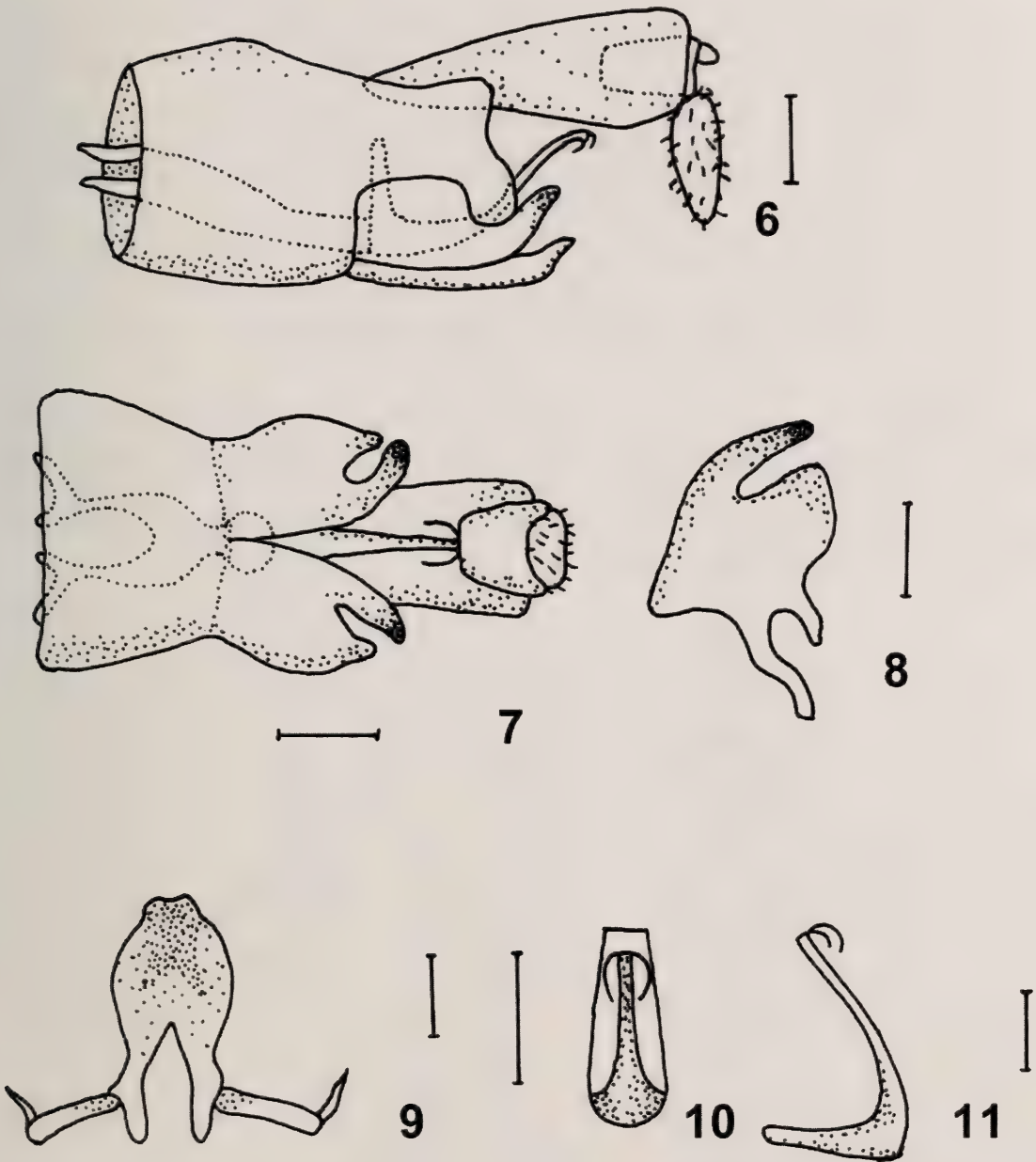
² Gazi University, Faculty of Science & Arts, Department of Biology, 06500 Teknikokullar Ankara, Turkey. E-mail: eminedemird@yahoo.com.

Etymology: The name of this new species is dedicated to my father Mustafa Demir.

Remarks: Similar to *P. dimorphum* Linnavuori from Africa and *P. paradoxum*, in the shape of the subgenital plate but differs from the former species by its longer crown with sides concave and more elongate lateral lobe of the subgenital plate and from both species in having a pair of apical aedeagal processes.



Figs. 1-5. *Paradorydium mustafai* sp. n., holotype male. 1. Habitus. Scale bar = 1.0 mm. 2. Left forewing. 3. Crown, dorsal view. 4. Crown, lateral view. 5. Paratype female, distal portion of abdomen, lateral view. Figures 2-5, scale bar = 0.5 mm.



Figs. 6-11. Male genitalia of *Paradorydium mustafai* sp. n., holotype male. 6. Genital capsule and anal tube, lateral view. 7. Same, ventral view. 8. Right style, dorsal view. 9. Connective, dorsal view. 10. Aedeagus, posterior view. 11. Aedeagus, lateral view. Scale bar = 0.1 mm.

***Paradorydium occidentale* Lindberg (Figs. 12-22)**

Paradorydium occidentale Lindberg, 1954: 208, Figs. 51 1-m.

Description: Length: male 4.5 – 5.3 mm, female 6.2 – 7.1 mm. Yellowish-green. Females darker than males. Crown and hemelytra with fine brownish-green punctation (some specimens [1 male and 4 females] with red punctation). Face with distinct dark lateral bands. Veins colored light yellow, indistinctly granulated.

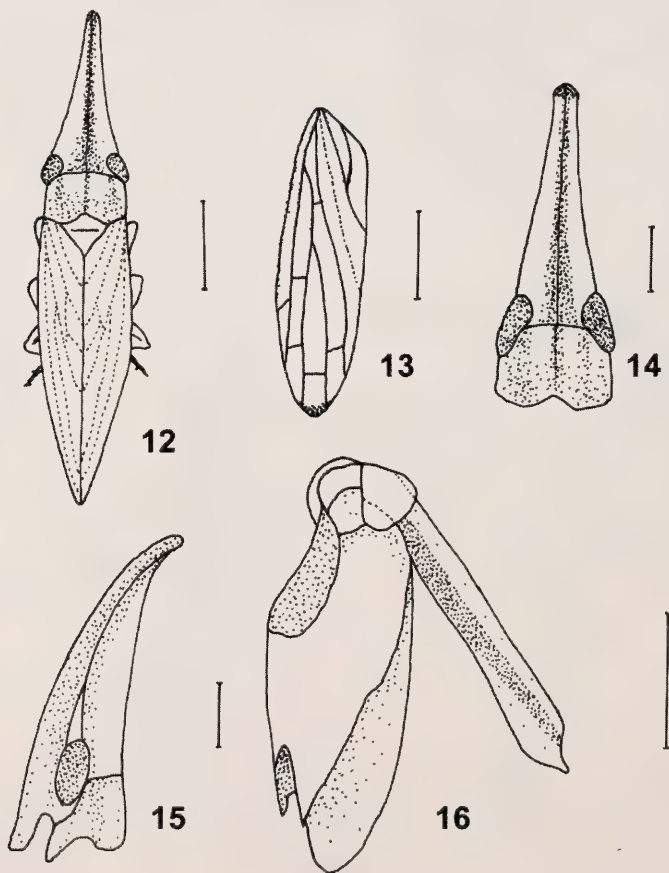
Crown (Figs. 14-15) tetrahedral in cross section, slightly flattened with apex slightly truncate; vertex 4-4.5 X as long as median length of pronotum (male and female respectively), median carina reaching to apex, lateral carinae more distinct than median carinae. Hemelytra transparent with slightly rounded apex enclosing entire abdomen.

Male genitalia as in Figs. 17-22. Side lobes of pygophore conical. Stem of aedeagus elongate, slightly recurved dorsad, without processes.

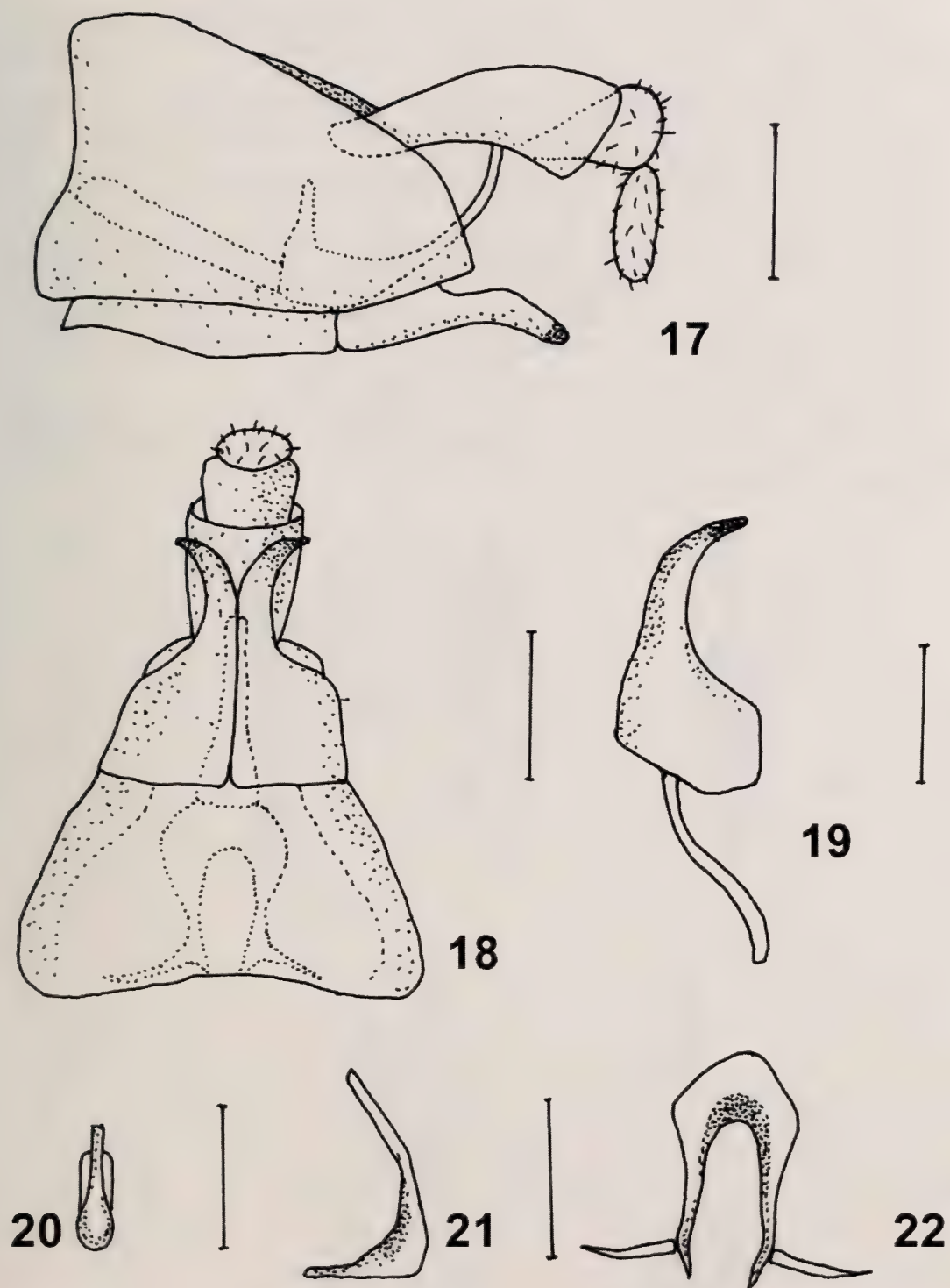
Female genitalia as in Fig. 16.

Material Studied: TURKEY: Southwest Anatolia, Antalya, Gazipaşa, Çalıpınar, 25 m, 12.05.2001 23♂ 30♀, on *Graminae*. Antalya, Manavgat, Demirciler, 40 m, 11.05.2001 1♂, on *Graminae*.

Remarks: The specimens from Turkey (new record) were identified by reference to the original figures and by comparison (by M. D. Webb) with a male and female from Cape Verde Island determined by Lindberg as *P. paradoxum*, deposited in the Natural History Museum, London. The species was previously recorded from the Canary Islands.



Figs 12-16. *Paradorydium occidentale*. 12. Habitus. 13. Left forewing. Scale bar = 1.0 mm. 14. Crown, dorsal view. 15. Crown, lateral view. 16. Paratype female, distal portion of the abdomen, lateral view. Figures 14-16, scale bar = 0.5 mm.



Figs. 17-22. Male genitalia of *Paradorydium occidentale*. 17. Genital capsule and anal tube, lateral view. 18. Same, ventral view. 19. Right style, dorsal view. 20. Aedeagus, posterior view. 21. Aedeagus, lateral view. 22. Connective, dorsal view. Scale bar = 0.1 mm.

***Paradorydium paradoxum* (Herrich-Schäffer) (Figs. 23-33)**

Jassus paradoxum Herrich-Schäffer, 1837.

Description: Length: male 6.5 – 7.0 mm, female 7.4 – 8.2 mm. Yellowish-green. Females darker than males. Crown and hemelytra with fine brownish-green punctation. Veins colored light yellow, indistinctly granulated.

Crown (Figs. 25-26) tetrahedral in cross section, apex slightly flattened; vertex 4-5 X as long as median length of pronotum (male and female respectively). Hemelytra transparent with slightly sharp apex enclosing entire abdomen.

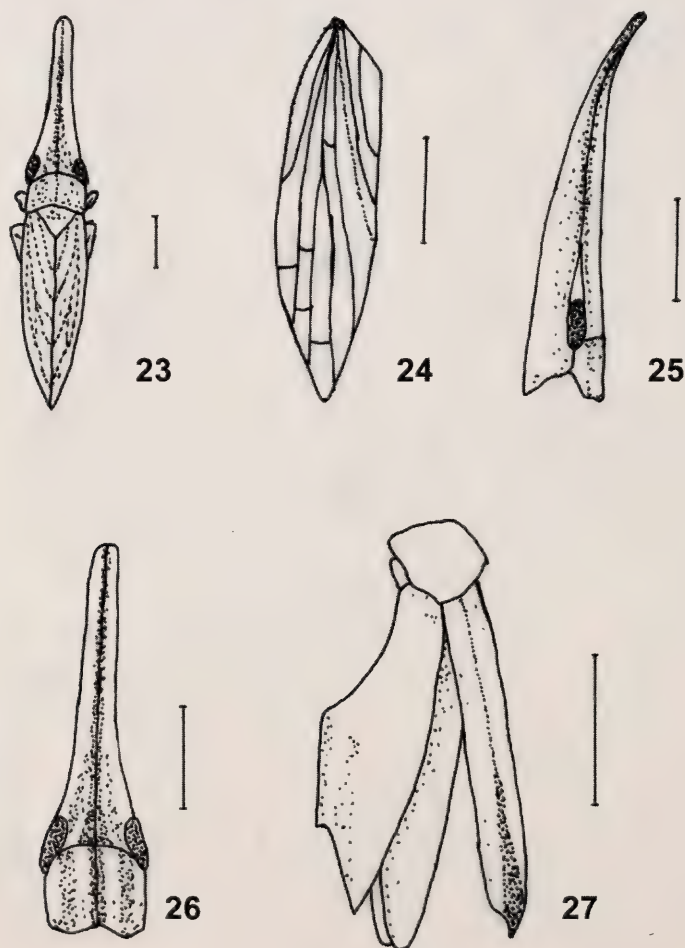
Male genitalia as in Figs. 28-33. Aedeagus with a pair of narrow basal processes.

Female genitalia as in Fig. 27.

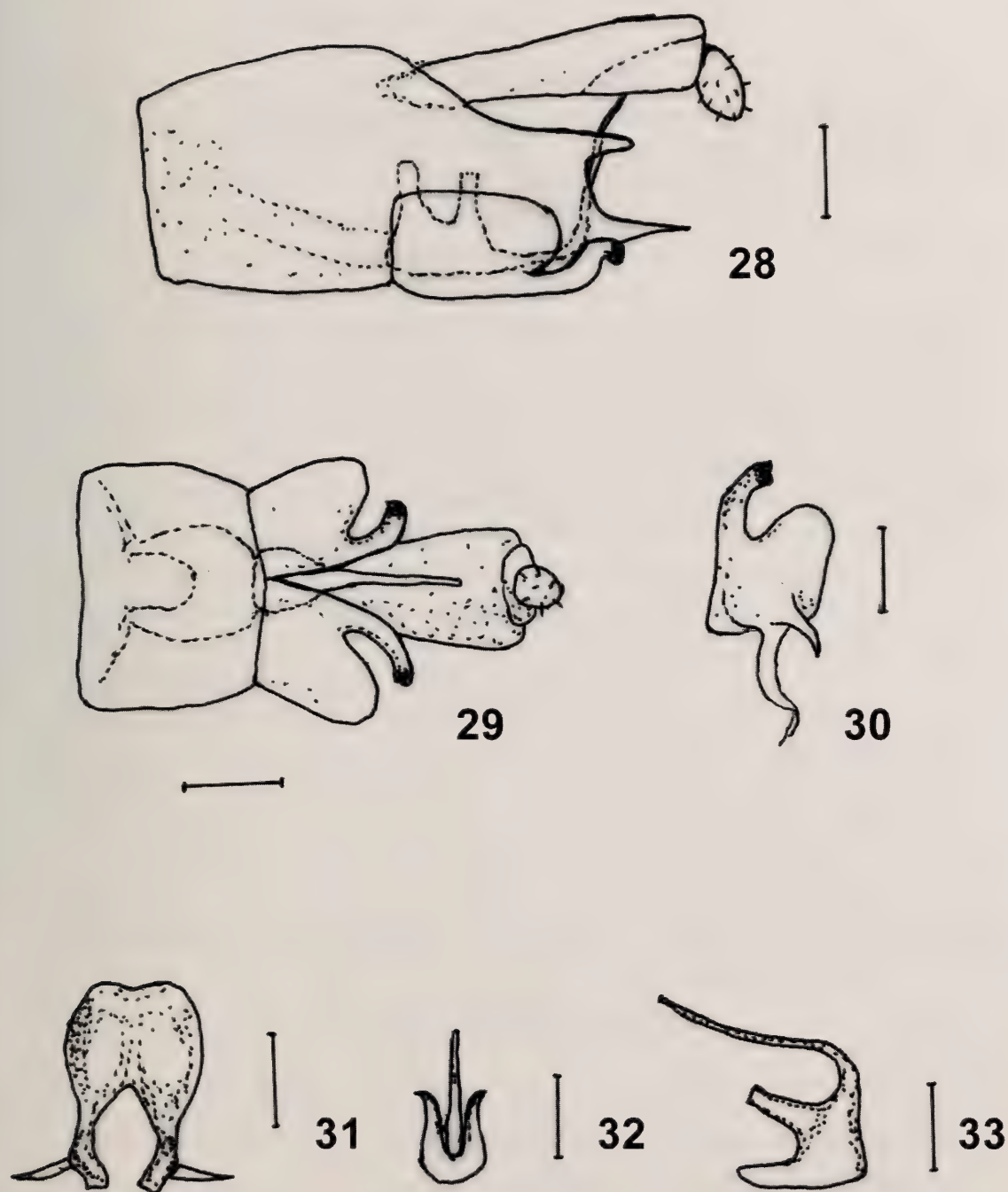
Material Studied: TURKEY: Southwest Anatolia, Antalya, Düzlerçamı, 280 m, 22 July 2001 2♂2♀, on *Graminae*, Middle Anatolia, Ankara, Sincan Mülk. Ayaş Mts. E. 1000 m, 20.07.2000 1♀, on *Graminae*, Sincan Mülk. Ayaş Mts. E. 1000 m, 17.06.2000 1♀, on *Graminae*, Kızılcahamam, Soğuksu, 1300 m, 07.06.1997 4♀, on *Graminae*, Soğuksu, 1300 m, 20.07.1997 2♂, on *Graminae*.

Distribution in Turkey: Middle Anatolia: Ankara and Southeast Anatolia: Diyarbakır (Dlabola, 1957; Lodos & Kalkandlen, 1982).

Remarks: Differing from the similar *Paradorydium lanceolatum* Burmeister in the flattened apex of the crown and aedeagus with narrow rather than triangular basal processes (D'Urso, 1992).



Figs. 23-27. *Paradorydium paradoxum*. 23. Habitus. 24. Left forewing. Scale bar = 1.0 mm. 25. Crown, lateral view. 26. Crown, dorsal view. 27. Paratype female, distal portion of the abdomen, lateral view. Scale bar = 0.5 mm.



Figs. 28-33. Male genitalia of *Paradorydium paradoxum*. 28. Genital capsule and anal tube, lateral view. 29. Same, ventral view. 30. Right style, dorsal view. 31. Connective, dorsal view. 32. Aedeagus, posterior view. 33. Aedeagus, lateral view. Scale bar = 0.1 mm.

ACKNOWLEDGEMENTS

I thank Dr. H. Abdul-Nour, Dr. M. D. Webb (Department of Entomology, Natural History Museum, London, England), and my parents for their help during different phases of this project.

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ANNOUNCEMENT

Our web page (www.geocities.com/entomologicalnews) has been updated. Among others, we now have revised guidelines to authors and all the published indexes to *Entomological News*.

TWO NEW SPECIES OF *Pentelicus* HOWARD (HYMENOPTERA: ENCYRTIDAE) FROM SOUTHERN CHINA¹

Yan-Zhou Zhang,² Hui Xiao,² and Da-Wei Huang^{2,3}

ABSTRACT: We describe two new species of *Pentelicus*, *Pentelicus orientalis* and *Pentelicus similis*, from southern China, the Oriental biogeographic region. Photomicrographs are provided to illustrate morphological characters of the new species. A key to worldwide species of *Pentelicus* is provided. All type specimens are deposited in Institute of Zoology, Chinese Academy of Sciences, Beijing (IZCAS).

KEY WORDS: *Pentelicus*, Hymenoptera, Encyrtidae, southern China, Oriental biogeographic region

Pentelicus Howard is a small genus in the Encyrtidae. Of the five recognized species of *Pentelicus*, *P. aldrichi* Howard (Howard 1895, Peck 1963, Gordh 1979), *P. confusus* (Ashmead) (Ashmead 1900, Peck 1963, Gordh 1979, Trjapitzin and Gordh 1979, Noyes and Hayat 1984) and *P. varicornis* (Girault) (Girault 1917, Peck 1963, Gordh 1979, Trjapitzin and Gordh 1979, Noyes and Hayat 1984) are distributed in the United States of America; *P. paliji* Khlopunov (Khlopunov 1979, Trjapitzin 1989) and *P. aeneifrons* (Girault) (Girault 1935, Noyes and Hayat 1984, Dahms and Gordh 1997) are known from the Palearctic and Australasian regions, respectively. Little has been known about biology of *Pentelicus* species except that McHugh (1993) recorded *Pentelicus* spp. as parasitoids of sphingid beetles (Coleoptera: Sphindidae).

Noyes and Hayat (1984) elucidated undetermined species of *Pentelicus* from Chinese Taiwan and India. In this paper, *P. orientalis* sp. n. and *P. similis* sp. n. are described from southern China as representatives of Oriental region. A key to all known species of *Pentelicus* is provided to facilitate species identification.

Morphological nomenclature follows Noyes and Hayat (1984), Huang and Noyes (1994). Absolute measurements are used for body length; relative measurements are used for other dimensions. All type specimens are deposited in the Institute of Zoology, Chinese Academy of Sciences, Beijing (IZCAS).

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SYSTEMATIC ENTOMOLOGY
FAMILY ENCYRTIDAE
Genus *Pentelicus* Howard, 1895

Pentelicus Howard, 1895: 611. Type species: *Pentelicus aldrichi* Howard, by monotypy.

Hemaenasius Ashmead, 1900: 374. Type species: *Hemaenasius confusus* Ashmead, by monotypy and original designation. Synonymy with *Pentelicus* by Noyes and Hayat, 1984: 322.

Epaenasomyia Girault, 1917: 3. Type species: *Epaenasomyia varicornis* Girault, by monotypy and original designation. Synonymy with *Pentelicus* by Noyes and Hayat, 1984: 322.

Cowperella Girault, 1935: 4. Type species: *Cowperella aeneifrons* Girault, by monotypy. Synonymy with *Pentelicus* by Noyes and Hayat, 1984: 322.

Diagnosis. Female: Body robust, usually dark brown and with metallic green or purple blue sheen; frontovertex about 1/3 head width, with small or large piliferous punctures; occipital margin sharp; facial impression frequently carinate at top of antennal scrobes; antennal scape varying from cylindrical to strongly flattened and expanded; pedicel often clearly longer than the first funicular segment, rarely subequal in length; funicle 6-segmented; clava 3-segmented, with apex slightly to strongly obliquely truncated; mandibles tridentate; dorsum of thorax moderately convex, with shallow or deep piliferous punctures; posterior margin of mesoscutum often convex and axillae distinctly separated in dorsal view; scutellum with an discernable median longitudinal ridge, laterally and posteriorly flanged; forewing often with an infusate pattern, sometimes hyaline; linea calva posteriorly open; filum spinosum present; marginal vein punctiform or a little longer than broad; stigmal vein slightly to clearly longer than postmarginal vein; apex of stigmal vein and apex of postmarginal vein connected by a naked, hyaline streak (Fig. 2); gaster about as long as thorax; cercal plates located in basal half of gaster; hypopygium nearly reaching apex of gaster; ovipositor not or hardly exerted. Male: generally similar to female except antenna (Fig. 5) and genitalia (Fig. 6); apex of stigmal vein and apex of postmarginal vein without a naked, hyaline streak.

Remarks. As a result of the comprehensive study of Indo-Pacific Encyrtidae by Noyes and Hayat (1984), *Hemaenasius* Ashmead, *Epaenasomyia* Girault and *Cowperella* Girault are junior synonymies of *Pentelicus* (Dahms and Gordh 1997). All known species of *Pentelicus* possess a discernable median longitudinal ridge on scutellum, which is a possible autapomorphy of the genus. However, the systematics of this genus is yet unsettled. Historically, *Pentelicus* has been placed in the Bothriorhorini (Howard 1895, Trjapitzin and Gordh 1978, Trjapitzin 1989), Discodiini (as *Hemaenasius* in Trjapitzin and Gordh 1978). Noyes and Hayat (1984) stated *Pentelicus* is probably related to *Leurocerus* Crawford, *Proleurocerus* Ferrière, *Zozoros* Noyes and Hayat, etc. We refrain to give our opinion pending a further study of these genera.

***Pentelicus orientalis* sp. n.**

(Figs. 1-6)

Diagnosis. Female: body (length about 1.2 mm) dark brown; antenna (Fig. 1) generally dark brown except apex of scape, F6 and sometimes apex of F5 yellow; antennal scape about 3 times as long as broad; frontovertex with very shal-

low reticulate sculpture or smooth-like, and with piliferous punctures much smaller than diameter of posterior ocellus; mesoscutum and scutellum covered with scaly reticulate sculpture, and with shallow piliferous punctures, but apex of scutellum often smooth; forewing (Fig. 2) with about basal 1/3 infusate, the rest hyaline, sometimes faintly infusate subapically.

Description. Female: Body (length about 1.2 mm) dark brown, head with blue sheen, dorsum of thorax with blue-green sheen; antennae with scape generally dark except apex yellow; pedicel dark brown; funicle dark brown except F6 and sometimes apex of F5 yellow; clava dark brown; forewing with about basal 1/3 infusate, the rest hyaline, sometimes faintly infusate subapically; legs including all coxae generally dark brown except apices of all femora and tibiae, and all tarsi brownish yellow.

Head. Head in dorsal view, about 2.5 times as wide as its median length; ocelli forming an angle about 90°; posterior ocelli separated from occipital margin by about half their own diameters and from inner eye margin by 1/3 their own diameters; eyes oval and covered with translucent setae, which are clearly longer than diameter of a facet; head in front view, antennal toruli situated below lowest eye margin; antennal scrobes deep and jointed at top of interantennal prominence which is clearly convex; antenna (Fig. 1) with scape obviously expanded and flattened, about 3 times as long as wide; pedicel about two and a half times longer than wide; funicular segments gradually shortening distad, F1 nearly 1.5 times as long as broad and slightly longer than F2; F6 slightly transverse; clava apically conspicuously obliquely truncated and a little longer than F3-6 combined. Relative measurements: head width 46, median head length 18, head height 40, frontovertex width 16, POL 10, OOL 1, OCL 1.5, scape length 21, scape width 7, malar space 14.

Thorax. Mesoscutum and scutellum covered with reticulate sculpture, scattered with shallow piliferous punctures, but scutellum sometimes apically smooth; forewing (Fig. 2) slightly more than 2.1 times as long as wide; marginal vein punctate; postmarginal vein about twice as long as marginal vein and little shorter than stigmal vein. Relative measurements: mesoscutum width 42, mesoscutum length 20, scutellum width 28, scutellum length 25, forewing length 90, forewing width 42, marginal vein length 2.5, postmarginal vein length 5, stigmal vein length 6.

Gaster. Gaster a little shorter than thorax; cercal plate located in basal half of gaster; hypopygium extending to apex of gaster; ovipositor sheath (Fig. 3) slightly exerted. Relative measurements: gaster length 50.

Male. Body length about 1.1 mm; similar to female except as follows: antennal scape generally yellow or yellow brown, with dorsal and ventral margin dark brown; pedicel dark brown; flagellum dark yellow brown; forewing hyaline (Fig. 4); scape a little expanded and flattened, about 3 times as long as broad; pedicel short; all funicular segments longer than wide (Fig. 5); genitalia as in Fig. 6.

Host. Unknown.

Distribution. P. R. China-Anhui, Fujian, Guangxi, Hubei and Jiangxi provinces.

Type material. Holotype female mounted on card; P. R. China, Fujian, Fuzhou, 9.vi.2001, Leg. Nai-quan LIN (IZCAS). Paratypes: 2 females, 6 males, same data as holotype; 6 females, P. R. China, Anhui, Xuancheng, v.2003, Leg. Zhong-li SHA; 1 female, P. R. China, Guangxi, Jinxiu, 2.vii.2000, Leg. Chao-dong ZHU; 1 female, P. R. China, Hubei, Badong, alt. 1500 m, 11.viii.1989, Leg. Da-wei HUANG; 1 female, P. R. China, Jiangxi, Dayu, alt. 450 m, 14.viii.1985, Leg. Chang-fang LI (IZCAS).

Differential Diagnosis. *Pentelicus orientalis* is close to *P. aeneifrons* (Girault) but females can be separated from the latter by the following characters: body completely dark brown (generally orange in *aeneifrons*); antennal scape 3 times as long as broad (twice as long as broad in *aeneifrons*); funicle dark brown except F6 yellow and sometimes apex of F5 yellow (in *aeneifrons*, funicle whitish except F2 dark brown).

Pentelicus similis sp. n.

(Figs. 7-8)

Diagnosis. Female: Body (length about 1 mm) dark brown; antennal scape yellow, sometimes basally brownish yellow; pedicel generally dark brown except apex yellow; F1-4 brownish yellow, F5-6 yellow; antennal clava dark brown;

antennal scape cylindrical, 5 to 6 times as long as broad; frontovertex with distinct reticulate sculpture, and with small piliferous pits; mesoscutum and scutellum entirely covered with scaly reticulate sculpture, and with shallow piliferous punctures; forewing (Fig. 8) nearly entirely hyaline but for basal 1/6 or so infusate.

Description. Female: Body (length about 1 mm) dark brown, head and dorsum of thorax with blue-green sheen; antennal scape yellow, sometimes basally brownish yellow; pedicel generally dark brown except apex yellow; F1-4 brownish yellow, F5-6 yellow; antennal clava dark brown; forewing nearly entirely hyaline but for basal 1/6 or so infusate; legs similar to *P. orientalis* in color.

Head: Head in dorsal view, nearly 2.25 times as wide as its median length; frontovertex slightly less than 1/3 head width and covered distinct reticulate and sparsely with small piliferous punctures; ocelli forming an angle about 90°; posterior ocelli about 1/3 their own diameters from occipital margin and about the same from inner eye margin; antenna (Fig. 7) with scape cylindrical, 5 to 6 times as long as wide; pedicel about two times as long as wide; F1 about 1.2 times as long as broad, and about equal to F2 in length; F6 slightly transverse; clava apically conspicuously obliquely truncated and about as long as F3-6 combined. Relative measurements: head width 47, median head length 21, head height 39, frontovertex width 17, POL 10, OOL 1, OCL 1, scape length 21, scape width 4, malar space 13.

Thorax: Mesoscutum and scutellum covered with distinct reticulate sculpture, scattered with shallow piliferous punctures; forewing (Fig. 8) nearly 2.2 times as long as wide; marginal vein punctate; postmarginal vein about twice as long as marginal vein. Relative measurements: mesoscutum width 44, mesoscutum length 18, scutellum width 30, scutellum length 25, forewing length 100, forewing width 45, marginal vein length 2, postmarginal vein length 4, stigmal vein length 5.5.

Gaster: Cercal plate located in middle of gaster; hypopygium nearly extending to apex of gaster; ovipositor sheath hardly exerted. Relative measurements: gaster length 45.

Male: Unknown.

Host. Unknown.

Distribution. P. R. China-Fujian.

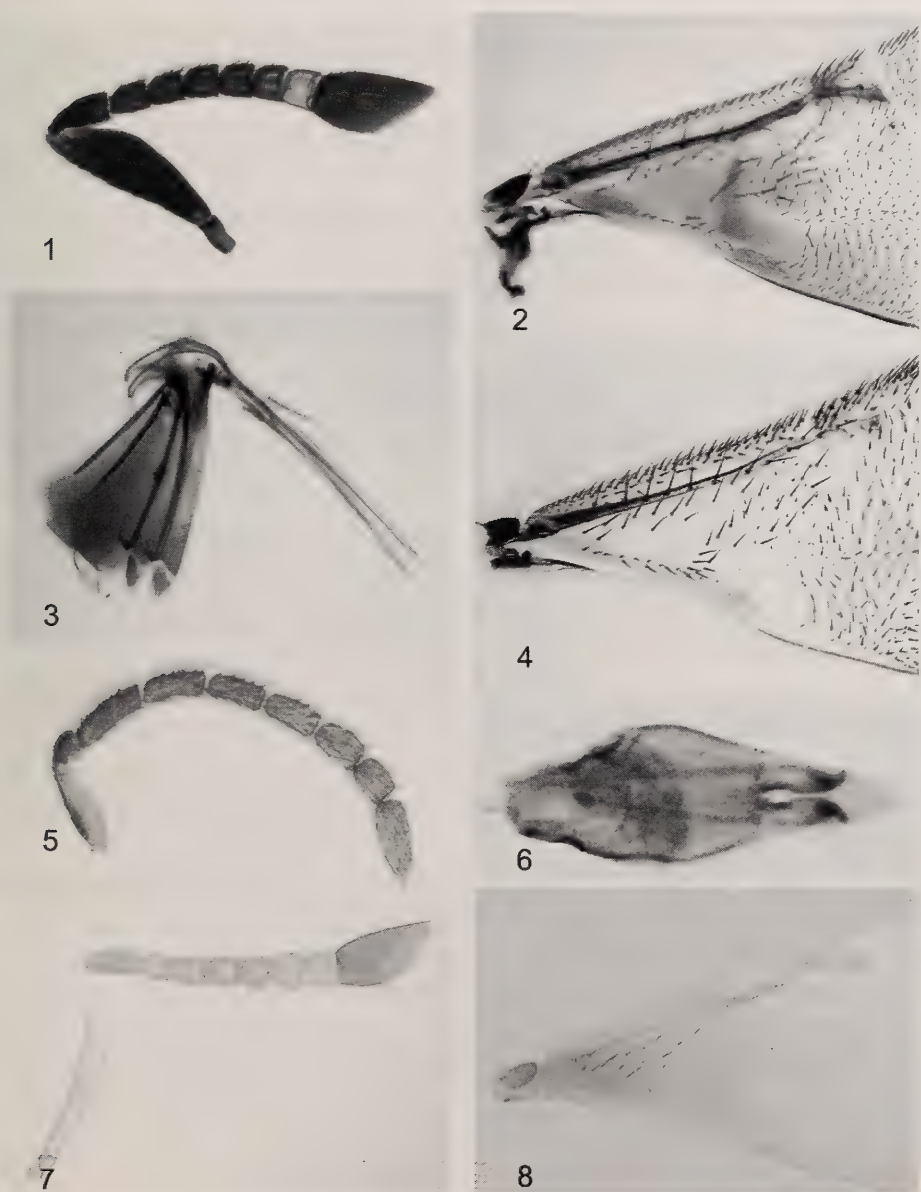
Type Data. Holotype female mounted on card, P. R. China, Fujian, Fuzhou, 20.vi.1997, Leg. Naiquan Lin (IZCAS). Paratype: 1 female mounted on card, the same data as holotype (IZCAS).

Differential Diagnosis. *P. similis* is very similar to *P. orientalis* but the females can be separated from the latter by the following characters: antennal scape cylindrical and 5 to 6 times as long as broad (antennal scape obviously flattened and expanded and about 3 times as long as broad in *orientalis*); scape yellow (scape nearly entirely dark brown in *orientalis*); forewing with basal 1/6 or so infusate (forewing with basal 1/3 or so infusate in *P. orientalis*).

Key to species of *Pentelicus*

- 1 Female; antennal clava 3-segmented and apically slightly to strongly obliquely truncated 2
- Male; antennal clava appearing 2-segmented and apically pointed.....8
- 2 Frontovertex with large and deep piliferous punctures, which only slightly smaller than diameter of posterior ocellus; fore wing hyaline.....3
- Frontovertex with shallow piliferous punctures much smaller than diameter of posterior ocellus; fore wing at least basally infusate 4
- 3 Funicle with F1 about as long as pedicel; clava about as long as F5-6 combined.....*P. aldrichi* Howard
- Funicle with F1 shorter than pedicel; clava about 1.7 times as long as F5-6 combined.....*P. paliji* Khlopunov
- 4 Antennal clava with apex distinctly obliquely truncated and the truncated part about half clava .. length 5
- Antennal clava with apex more or less rounded or somewhat transversely truncated and the truncated part shorter than 1/3 clava length.....7
- 5 Body generally orange; antennal scape twice as long as broad*P. aeneifrons* (Girault)

- Body completely dark brown; antennal scape at least 3 times as long as broad 6
- 6 Antennal scape about 3 times as long as broad (Fig. 1); forewing with at least basal 1/3 infusate (Fig. 2)*P. orientalis* sp. n.
- Antennal scape 5 to 6 times as long as broad (Fig. 7); forewing with basal 1/6 or so infusate ... (Fig. 8)*P. similis* sp. n.
- 7 Antennae with F1 yellow brown or dark yellow brown; forewing with basal infusate area not interrupted by hyaline stripe*P. confusus* (Ashmead)
- Antennae with F1 yellow; fore wing with basal infusate area interrupted by hyaline stripe*P. varicornis* (Girault)
- 8 Body length 2.5 mm; frontovertex with large and deep piliferous punctures, which only slightly smaller than diameter of posterior ocellus; antennal scape nearly 4 times as long as wide*P. palijsi* Khlopunov
- Body length 1.1 mm; frontovertex with shallow piliferous punctures much smaller than diameter of posterior ocellus; antennal scape 3 times as long as wide*P. orientalis* sp. n.



Figs. 1-8. 1-6, *Pentelicus orientalis* sp. n., 1. Antenna, female. 2. Forewing, female. 3. Ovipositor, female. 4. Forewing, male. 5. Antenna, male. 6. Genitalia, male. 7-8. *Pentelicus similis* sp. n., 7. Antenna, female. 8. Forewing, female.

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A NEW WINGLESS STONEFLY, *SCOPURA JIRI* (PLECOPTERA: SCOPURIDAE), FROM KOREA¹

Young Hun Jin² and Yeon Jae Bae²

ABSTRACT: A new species, *Scopura jiri* sp. n., in the wingless stonefly family Scopuridae is described from Korea with figures of key characters. The male adult of *S. jiri* can be distinguished from other congeners by the elongated lateral projections of the epiproct, by the absence of a basal projection of the cerci, and by the presence of a median sclerite on the penis. The nymph can be distinguished by the presence of a pair of lateral swellings and a median swelling on the epiproct. Distributional and taxonomic remarks are provided.

KEY WORDS: Plecoptera, Scopuridae, *Scopura jiri*, wingless stonefly, headwater stream, Korea

The Scopuridae is unique among the Plecoptera taxa due to their absolute winglessness in both the adult and nymphal stages. The family is regarded as a basal clade of Holognatha in the Plecoptera phylogeny (Zwick 2000). The family includes seven species in the monotypic genus *Scopura* and is geographically limited to Northeast Asia (Uchida and Maruyama 1987; Jin and Bae 2005).

Uéno (1929) described *Scopura longa* from Japan. Uchida and Maruyama (1987) described *S. montana* Maruyama, *S. bihamulata* Uchida, and *S. quatuorhamulata* Uchida from Japan and *S. laminata* Uchida from Korea. Jin and Bae (2005) described *S. gaya* Jin and Bae and *S. scorea* Jin and Bae from Korea. In addition to the above species, one new *Scopura* species was recently discovered in the southwestern part of Korea. We herein describe this species.

The adult and nymphal materials were collected with hand nets. They were preserved in 80 percent ethyl alcohol and deposited in the Aquatic Insect Collection of Seoul Women's University (SWU-AIC). The characters and terminology used in this paper follow those of Jin and Bae (2005).

Scopura jiri sp. n.

(Figs. 1-13)

Adult Male. Body length 18.5mm; body surface shiny, light brown to brown with dark brown markings. **Head:** Head width 3.4mm. **Thorax:** Notum greatly expanded, with irregular dark brown markings. Pronotum (Fig. 1) lateral expansions without dorsal hump; distance between anterolateral corners 3.3mm; posterolateral expansion well developed and round; length of posterolateral expansions 0.8mm; distance between posterolateral expansions 3.9mm. Mesonotum (Fig. 2) lateral expansions without dorsal hump; length of posterolateral expansions 0.7mm; distance between posterolateral expansions 4.5mm; anterior projections pointed (height 0.2mm anteriorly); posterior projections pointed (height 0.2mm posteriorly). Metanotum (Fig. 3) lateral expansions without dorsal hump; length of posterolateral expansions 0.6mm; distance between posterolateral expansions 4.1mm; anterior projections pointed and greatly elongated to level of posterior projections (height 0.2 mm posteriorly); posterior projections moderately angled (height 0.2 mm posteriorly). Femora light brown, without stripe. Tibiae light brown, without stripe. **Abdomen:** Abdominal terga I-VII (Fig. 4) with dark brown transverse stripes (stripes on anterior terga thicker: terga I-II almost dark brown; stripes on

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terga III-V relatively thick and distinct; stripes on terga VI-VII relatively thin and vague). Tergum IX (Fig. 5) posterior 2/3 slightly elevated dorsally from lateral view, with setae in posterolateral parts and posterior margin. Epiproct (Figs. 6-7) with pair of lateral projections and pair of submedian projections; lateral projections elongated and widely separated (0.8mm in distance between apices of lateral projections), located ca. 2/3 apically and as high as top of membranous part of epiproct, relatively distant from membranous part of epiproct, curved anteriorly from lateral view, with short setae posteroapically; submedian projections small and relatively widely separated, apically blunt and directed anteriorly; membranous part of epiproct U-shaped, with tiny setae. Cerci (Figs. 8-9) without basal projection; base of cerci with many short setae along posteromesial margin. Penis (Fig. 10) apically dark brown, with lateral and median sclerites; lateral sclerites elongated, apically narrower and darker, basally broader and lighter; median sclerite bell-shaped, apically darker.

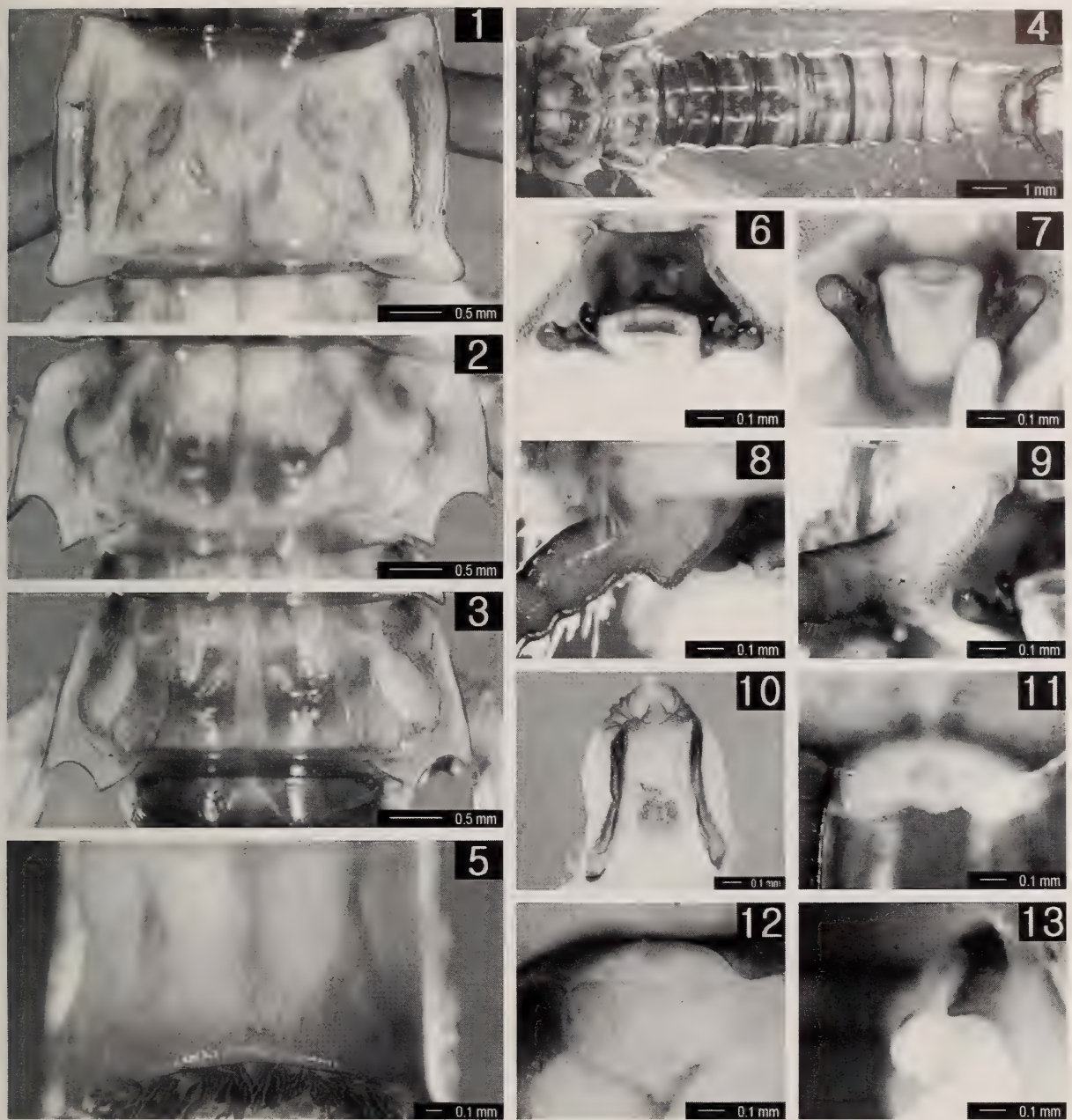
Adult Female. Unknown.

Nymph. General body shape and color pattern similar to adult but blunt in shape and dull in color. Epiproct of mature male nymph (Figs. 11-13) with median and pair of lateral membranous swellings, with dorsal transverse sclerite and concavity; median swelling located basally; lateral swellings directed posteriorly (not expanded laterally from dorsal view) (Fig. 11), located laterally and lower than concavity from posterior view (Fig. 12), and located basally from lateral view (Fig. 13).

Differential Diagnosis. *Scopura jiri* sp. n. can be distinguished from other congeners by the following characters. The male adult of *S. jiri* possesses two pairs of distinct projections on the epiproct (submedian and lateral projections), similar to the other Korean species (*S. gaya*, *S. laminata*, and *S. scorea*) and a Japanese species (*S. quattuorhamulata*). Both *S. jiri* and *S. quattuorhamulata* possess widely separated submedian projections in the epiproct, but the lateral projections of *S. jiri* (Figs. 6, 7) are longer than those of *S. quattuorhamulata*. The male adult of *S. jiri* can also be distinguished by the absence of a basal projection of the cerci (Fig. 8, 9) and by the presence of a round median sclerite of the penis (Fig. 10). The nymph of *S. jiri* can be distinguished from other species of *Scopura* by the presence of both a pair of lateral swellings and a basal median swelling in the epiproct. The shape of the epiproct of *S. jiri* is similar to that of *S. scorea*, but the lateral swellings of *S. jiri* are in a lower location than those of *S. scorea* from a lateral view (Fig. 13).

Remarks. When Uchida and Maruyama (1987) described *S. laminata* (nymph only) from Odaesan (Mt.) in the middle of the Korean Peninsula, they presented another type of nymph, noted as the “Jirisan type of *S. laminata*,” from Jirisan (Mt.) (see material examined, below). These nymphs are separated by the degree of the swellings on the epiproct. The male and female adults of *S. laminata* were described by Jin and Bae (2005) based on material collected from the type locality of *S. laminata*. The adults of the “Jirisan type of *S. laminata*,” however, have not been collected from the locality visited by Uchida and Maruyama (1987). It is possible that the “Jirisan type of *S. laminata*” belongs to *S. jiri*, not only because the shape of the nymphal epiproct is similar, but also because the type locality of *S. jiri* (Nogodan in Jirisan) is close (ca. 15 km) to Uchida and Maruyama’s (1987) locality of the “Jirisan type of *S. laminata*” (Hanshingyegok in Jirisan).

Etymology. The specific epithet *jiri* (noun) refers to the type locality.



Figs. 1-10. *Scopura jiri* sp. n., adult male: 1. pronotum. 2. mesonotum. 3. metanotum. 4. abdominal terga. 5. 9th abdominal tergum. 6. epiproct, dorsal. 7. epiproct, posterior. 8. basal cercus, dorsal. 9. basal cercus, posterior. 10. penis, dissected.

Figs. 11-13. *Scopura jiri* sp. n., mature male nymph: 11. epiproct, dorsal. 12. epiproct, posterior. 13. epiproct, lateral.

Material Examined. *Holotype*: Male adult (SWU-PLE-501), South Korea, Jeollanam-do (province), Gurye-gun, Sandong-myeon, Jwasa-ri, Jirisan (Mt.), Nogodan, a headwater stream at 100m west from Nogodan shelter, alt. 1300m, 27-X-2003, Y. H. Jin [SWU-AIC]. *Paratypes*: 1 male and 1 female nymphs (SWU-PLE-502), same locality and data as holotype [SWU-AIC]; 8 male and 10 female nymphs (SWU-PLE-503-512), same locality as holotype, 12-VIII-2000, D. H. Won [SWU-

AIC]. *Other materials*. 1 female nymph, same locality and data as holotype [SWU-AIC]; 2 female nymphs, same locality as holotype, 12-VIII-2000, D. H. Won [SWU-AIC]. *Scopura* sp. ("Jirisan type of *S. laminata*"): 6 male and 5 female nymphs, Korea, Gyeongsangnam-do, Chirisan (= Jirisan), Hanshingyegok (valley), alt. 1400m, 5-VI-1983, S. Uchida [Lake Biwa Museum].

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ERRATA

Volume 115(4), page 213. Complete author list should read J. M. Webb, D. W. Parker, D. M. Lehmkuhl, and W. P. McCafferty.

Volume 115(5), page 298. Title should read "Index – Volume 115 (1-5) 2004."

A NEW SPECIES OF *AMPHINEMURA* (PLECOPTERA: NEMOURIDAE) FROM CHINA¹

Weihai Li,^{2,3} Ding Yang,^{2,3} and Ignac Sivec⁴

ABSTRACT: *Amphinemura elongata*, a new species of Nemouridae (Plecoptera) from China is described. Remarks on relationships with the closest species, *A. fleurdelia* Wu, are given.

KEY WORDS: Plecoptera, Nemouridae, *Amphinemura*, New species, China

The genus *Amphinemura* Ris belongs to the subfamily Amphinemurinae, and is distributed in the Holarctic and Oriental regions. It currently contains 124 known species worldwide, including 37 from China. The species of *Amphinemura* from China were studied mainly by Wu (1938, 1962, 1973) and Zhu and Yang (2002, 2003). In the present paper, we describe one new species. Morphological terminology follows that of Baumann (1975). The type of new species are deposited in the Entomological Museum of China Agricultural University (CAU), Beijing.

Amphinemura elongata, NEW SPECIES (Figs. 1-5)

Diagnosis: Tergum 9 distinctly constricted medially. Epiproct in dorsal view with one pair of spine-like lateral processes distinctly shorter than median process, and single median process slightly curved upward at tip. Median lobe of paraproct strongly spiral; outer lobe long and thin.

Male: Body length 5.2 mm; forewing length 6.5 mm, hindwing length 5.0 mm. Head dark brown; antennae yellowish brown; mouthparts dark brown. Thorax brown; wings hyaline; legs yellowish brown. Abdomen brownish yellow; hypoproct including cerci brownish yellow; hairs on abdomen mostly pale.

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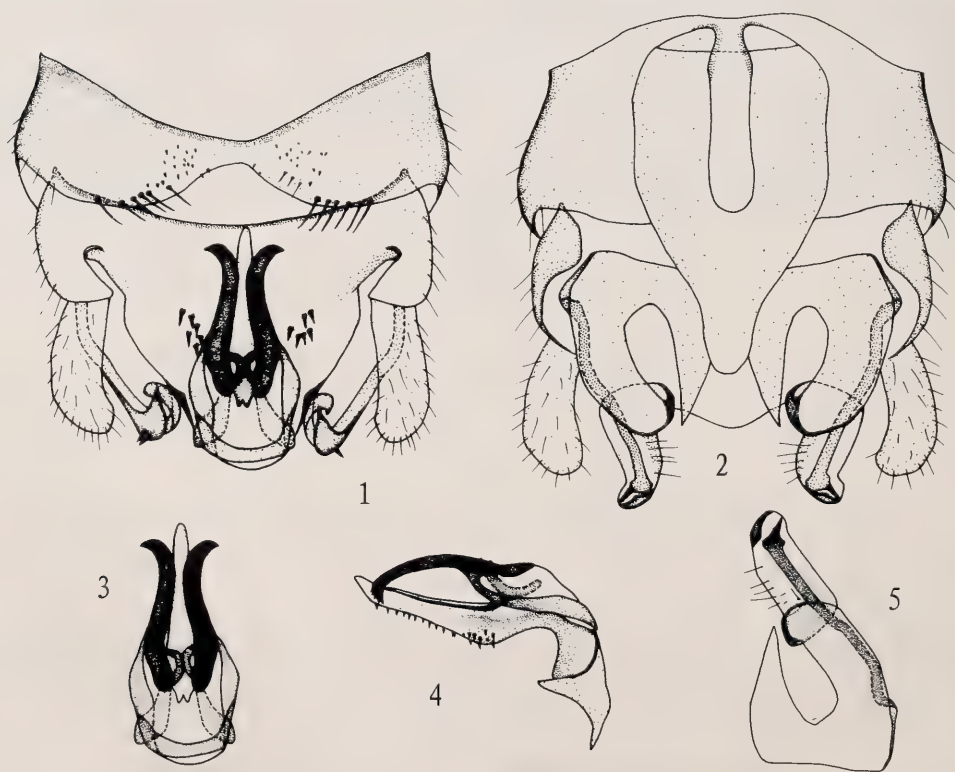
Genitalia (Figs. 1-5): Tergum 9 weakly sclerotized except basal margin distinctly sclerotized, rather constricted medially, with large triangular mid-anterior incision and distinct mid-posterior incision, and with a few dark long hairs along posterior margin and two groups of black tiny spines at the middle. Sternum 9 with slender vesicle slightly constricted medially; hypoproct rather wide basally, then distinctly tapering toward tip, elongated upward to base of epiproct. Tergum 10 weakly sclerotized except basal margin distinctly sclerotized, with a large median concavity bearing 6 black spines closely located along mid-lateral margin of the concavity. Cercus membranous, long and nearly cylindrical. Epiproct divided into one pair of strongly sclerotized and long spine-like lateral processes with tiny spines apically and single sclerotized median process slightly curved upward apically with ventral tiny spines along keel-like ventral sclerite. Paraproct divided into three lobes: outer lobe rather long and thin, heavily sclerotized, nearly as long as median lobe, curved inward medially, and with one or two small spines at the tip; median lobe spiral and partly sclerotized with a sharp spine; inner lobe triangular, weakly sclerotized, much shorter than outer lobe, with acute tip.

Female: Unknown.

Holotype male, **Zhejiang:** Qingyuan, Baishanzu Mountain, Wulingkeng, 1994. IV. 22, H. Wu.

Distribution: China (Zhejiang).

Etymology: The specific name refers to the long outer lobe of paraproct.



Figs. 1-5. *Amphinemura elongata* sp.n. (male). 1. Terminalia, dorsal. 2. Terminalia, ventral. 3. Epiproct, dorsal. 4. Epiproct, lateral. 5. Right paraproct.

Remarks: The new species is closely related to *A. fleurdelia* (Wu) described from Fujian and also recorded in Guangdong, but may be separated from the latter in the following features: spine-like lateral processes of epiproct distinctly shorter than median process and with tiny spines at tip, median process curved upward at tip; median lobe of paraproct strongly spiral, outer lobe rather long and thin. In *A. fleurdelia*, the lateral process of epiproct is nearly as long as the median process which is curved downward in an angle and has no tiny spines at tip; the median lobe of paraproct is not spiral, the outer lobe is rather short (Figs. 6-10).

***Amphinemura fleurdelia* (Wu) (Figs. 6-10)**

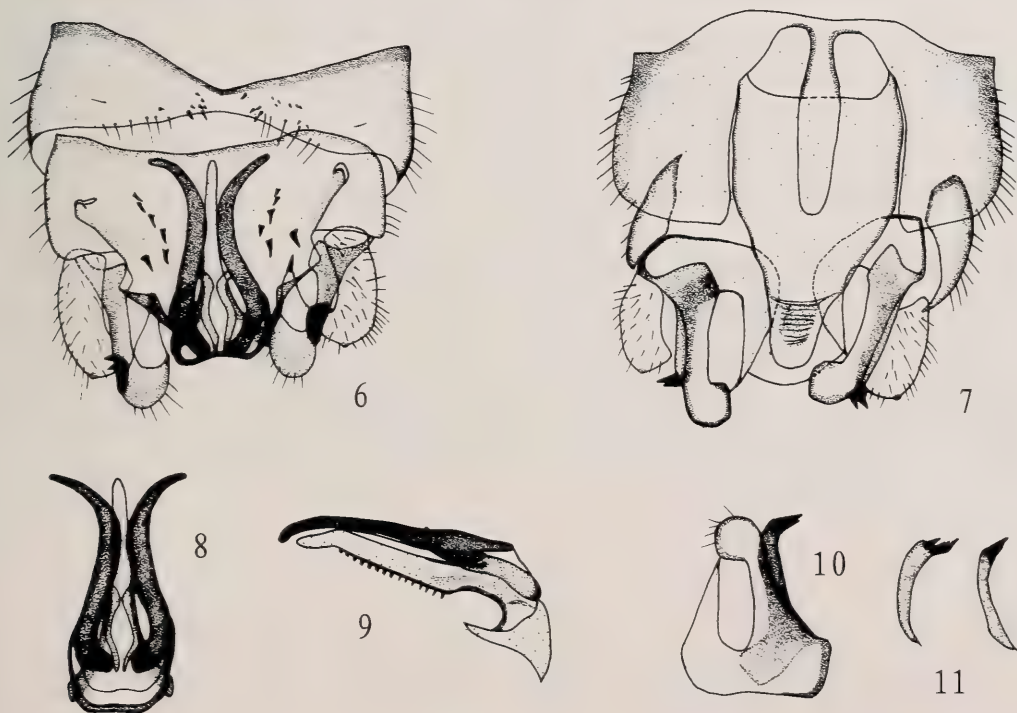
Nemoura (*Protonemoura*) *fleurdelia* Wu, 1949, Peking Nat. Hist. Bull. 17: 253.

Type locality: Ta-chu-luan, Shao-wu, Fukien.

Diagnosis: Tergum 9 distinctly constricted medially. Epiproct with one pair of long spine-like lateral processes nearly as long as median process, and single median process slightly curved downward apically in an angle. Median lobe of paraproct strongly curved inward but not spiral and outer lobe short.

Specimens examined: 1 male, Guangdong, Ruyuan, Nanling National Natural Reserve, 2003. III. 26, D. Yang; 2 males, Guangdong, Yingde, Shimentai National Forest Garden, 2003. III. 28, D. Yang.

Distribution: China (Fujian, Guangdong).



Figs. 6-11. *Amphinemura fleurdelia* (Wu) (male). 6. Terminalia, dorsal. 7. Terminalia, ventral. 8. Epiproct, dorsal. 9. Epiproct, lateral. 10. Right paraproct. 11. Variation of right outer lobe of paraproct.

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**NOTES ON THE
PLATYPALPUS PALLIDIVENTRIS-CURSITANS SPECIES GROUP
(DIPTERA: EMPIDIDAE) FROM CHINA, WITH THE DESCRIPTION
OF A NEW SPECIES AND A KEY¹**

Ding Yang^{2,3} and Haidong Yu⁴

ABSTRACT: One species of the *Platypalpus pallidiventris-cursitans* species group (Diptera: Empididae) is described as new to science: *Platypalpus beijingensis* sp. n., which represents the first record of the genus *Platypalpus* Macquart in Beijing. The species of the *Platypalpus pallidiventris-cursitans* species group known from China are keyed.

KEY WORDS: Diptera, Empididae, *Platypalpus*, new species, China

The genus *Platypalpus* Macquart is easily identified amongst Palaearctic Tachydromiini by the following features: eyes narrowly separated on face, mid leg raptorial, and the presence of an anal cell (Chvåla, 1975; Grootaert and Chvåla, 1992). The genus is distributed worldwide with some 250 species in Europe (Chvåla and Kovalev, 1989; Grootaert and Chvåla, 1992) and about 60 species in the Oriental region (Smith 1975; Yang and Yang 1989, 1990; Saigusa and Yang, 2002). Thirty-three species are known to occur in China.

Beijing is a semi-humid region with a subtemperate climate and belongs to the North China region of the Palaearctic realm. The genus *Platypalpus* is recorded from Beijing for the first time with one new species belonging to the *P. pallidiventris-cursitans* species group. The group is characterized by the mesonotum grayish dusted, humerus with one long bristle, mid femur with one row of pv behind two rows of v and mid tibia with long acute spur (Chvåla, 1975; Grootaert and Chvåla, 1992). A key to the species of the group from China is given. The specimens in 75 percent alcohol, which were collected in Mentougou by Mr. Xingyue Liu and Ms. Lili Zhang (Beijing), are deposited in the Insect collection of China Agricultural University (CAU), Beijing.

Here we follow Steyskal and Knutson (1981) and Yang and Yang (2004) in treating the dance flies as a single family, the Empididae. Morphological terminology mainly follows Chvåla (1975) except the male genitalia follow Sinclair (2000). The following abbreviations are used: acr-acrostichial, dc-dorsocentral, h-humeral, oc-ocellar, npl-notopleural, prsc-prescutellar, psa-postalar, sc-scutellar, v-ventral, vt-vertical.

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***Platypalpus beijingensis* Yang and Yu, NEW SPECIES**
(Figs. 1-5)

Diagnosis: Belonging to *P. pallidiventris-cursitans* group. 1 vt. Antenna black; first flagellomere long conical. Palpus dark brownish yellow, acr biseriate with rows distinctly separated. Mid tibia with long, acute, apical spur.

Description: Male. Body length 3.0 mm, wing length 2.7 mm. Head black with dense pale gray pollen. Eyes narrowly separated; face slightly narrower than frons. Hairs and bristles on head pale. Ocellar tubercle with 2 oc and 2 posterior hairs; 1 vt. Antenna black; scape without dorsal bristles; pedicel with circlet of pale subapical bristles; first flagellomere long conical, 2.1 times longer than wide; arista 2.5 times as long as first flagellomere, black, minutely pubescent. Proboscis shiny black, with sparse pale hairs; palpus dark brownish yellow, with pale hairs and 2 pale apical bristles.

Thorax black with pale gray pollen; sternopleuron with a large shiny black spot. Thorax with pale hairs and bristles, hairs on anterior 2/3 of mesonotum sparse; 1 h curved inward, 2 npl, acr and dc short and hair-like, acr biseriate with rows distinctly separated (distance between two acr rows narrower than that between acr row and uniseriate dc row), 1 prsc (belonging to acr), 1 psa; scutellum with 2 pairs of sc, lateral sc less than 1/2 length of apical sc. Legs brownish yellow; tarsomeres 1-2 with brown tip, tarsomeres 3-5 dark brown. Hairs and bristles on legs pale, but tarsi with some blackish hairs. Fore and mid femora distinctly thickened, fore femur 1.6 times and mid femur 1.8 times as wide as hind femur; mid femur with two rows of very short black inner ventral spines and two rows of long yellow outer v (antero-outer v shorter than postero-outer v); mid tibia with row of black thin v and long, acute, apical spur. Wing hyaline; veins dark yellow; first basal cell shorter than second basal cell, distance between r-m and m-cu longer than length of r-m; nearly straight R4+5 and gently bent M weakly convergent apically. Squama yellow with pale hairs. Halter yellow with brown base.

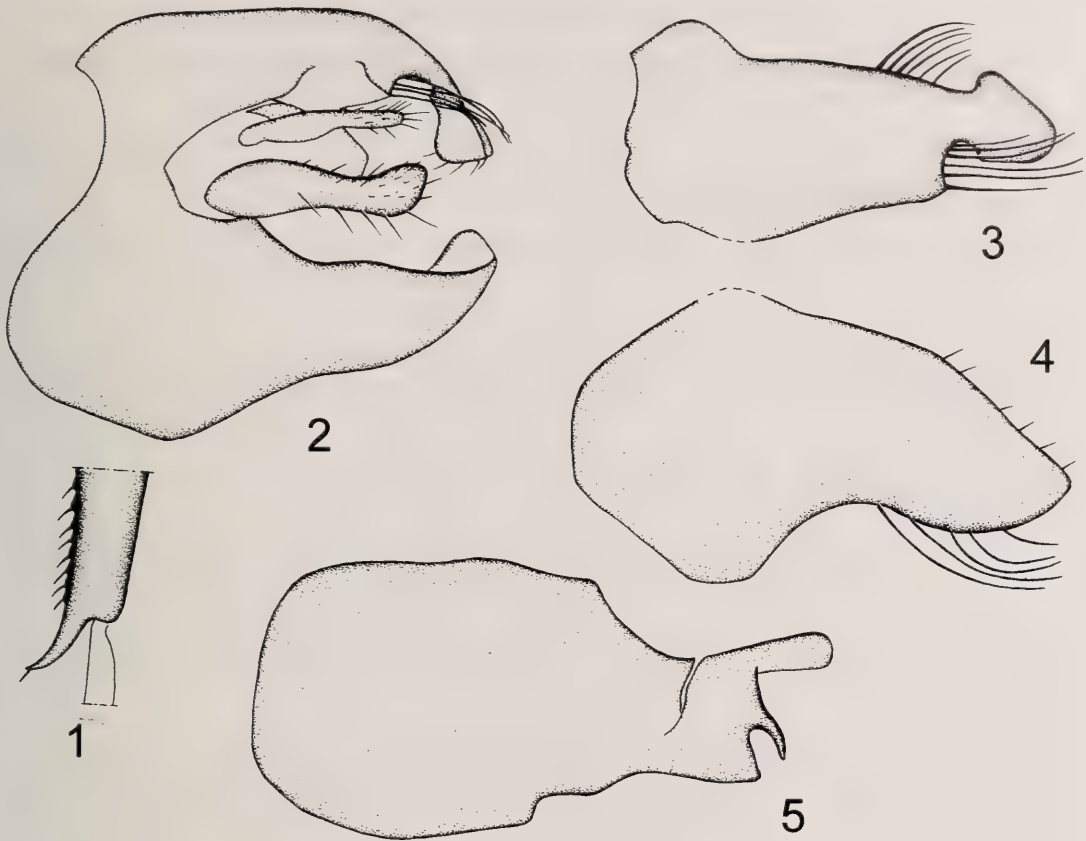
Abdomen shiny black without distinct pollen. Hairs on abdomen pale. Male genitalia (Figs. 2-4): Left epandrial lobe wide with row of 5 long bristles at outer margin, its surstylus not distinctly separated, subtriangular; right epandrial lobe narrow with row of long lateral and apical bristles near surstylus, its surstylus not distinctly separated, short and obtuse apically; left cercus slightly bent, longer and thicker than right cercus, right cercus narrow and nearly straight; hypandrium much longer than wide, narrow apically, with finger-like lateral and hook-like median processes.

Female: Body length 2.7-2.9 mm, wing length 3.2-3.5 mm. Cerci long and finger-like. Otherwise, similar to male.

Type Data: Holotype, male, Beijing, Mentougou, Longmenjian, 2004. VI. 3, Xingyue Liu (CAU). Paratypes: 5 females, Beijing, Mentougou, Longmenjian, 2004. VI. 3, Lili Zhang (CAU).

Etymology: The species is named after the type locality Beijing.

Remarks: The new species is somewhat similar to *P. parvula* Collin from the Russian Far East, but it can be separated from the latter by its larger body size (body length 2.7-3.0 mm), first flagellomere 2.1 times as long as wide, and the mid and hind femora entirely yellow. In *P. parvula*, the body is small-sized (body length 1.25 mm), the first flagellomere is shorter (about 1.25 times longer than wide), and the apical halves of mid and hind femora are dark tawny brown (Collin, 1941).



Figures 1-5. *Platypalpus beijingensis* sp. n., male: 1. apical portion of mid tibia; 2. genitalia, dorsal view; 3. right epandrial lobe; 4. left epandrial lobe; 5. hypandrium.

Key to species of the *pallidiventriscursitans* group from China

- | | |
|--|---------------------------------------|
| 1. 1 vt; antenna black; Tibet, Henan, Beijing | 2 |
| 2 vt; antenna yellow; Henan | <i>P. henanensis</i> Saigusa and Yang |
| 2. Femora not entirely yellow; Tibet | 3 |
| Femora entirely yellow; Henan, Beijing | 4 |
| 3. All coxae yellow; apices of mid and hind femora brownish yellow | <i>P. variegatus</i> Yang and Yang |
| Mid and hind coxae brownish; median portions of fore and mid femora and apical half of hind femur brownish | <i>P. xizangenicus</i> Yang et Yang |
| 4. Bristles on head and thorax black; 6-seriate acr; Henan | <i>P. neixiangensis</i> Yang et Yang |
| Bristles on head and thorax pale; biseriate acr; Beijing | <i>P. beijingensis</i> sp. nov. |

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FIVE NEW SPECIES OF *ACRULOGONIA* LEAFHOPPERS (HOMOPTERA: CICADELLIDAE) FROM COLOMBIA¹

Paul H. Freytag²

ABSTRACT: Five new species are added to the genus *Acrulogonia* from Colombia; *A. acuta*, *A. undulata*, *A. forficata*, *A. obtusa*, and *A. lobata*. A key to the congeneric males from Colombia is included.

KEY WORDS: *Acrulogonia*, new species, Homoptera, Cicadellidae, Cicadellinae, Colombia

The genus *Acrulogonia* was described by Young (1977) in his revision of the Cicadellini of the New World. Included at that time were 11 species, 2 from southern Central America and 9 from northern South America. Godoy and Nielson (2000) added two more species from Central America. Four of the species are known from Colombia: *A. chocona* Young, *A. defectiva* Young, *A. ordinaria* Young and *A. sparsa* Young (Freytag and Sharkey, 2002). In this paper, five new species are described from recent collections in Colombia.

Most species are about the same size (5.5 to 8.5 mm) and with a similar color pattern, shared with the genus *Oragua*. The two genera are separated by *Acrulogonia* having the male pygofer bifurcate at apex and the aedeagus tubular and with processes at apex. In *Oragua* the male pygofer is not bifurcate and the aedeagus is small and usually without apical processes. Also, the females of the two genera are similar; in *Acrulogonia* the seventh sternum is enlarged with a median posterior notch, and in *Oragua* it is not enlarged and with a median posterior acute process. For the reasons above both sexes are fairly easy to identify to genus, but usually only the males differ enough to separate individuals to species. Females are identified mostly by association with males collected from the same locality. Associations may be incorrect as several species can occur in the same locality. All types of the species described in this paper are deposited in the collection of the Instituto von Humboldt, Villa de Leyva, Colombia.

Key to the species of *Acrulogonia* (males only) from Colombia

1. Pygofer rounded or short 2
- 1'. Pygofer longer and narrowing to apex, which has a hook or spine dorsad and a thin lobe ventrad (Fig. 1) 3
2. Pygofer rounded in lateral view; aedeagus curved dorsad, with lobe-like processes at apex*A. defectiva* Young
- 2'. Pygofer short, with a short dorsal caudal process; aedeagus curved ventrad, with long ventral processes.....*A. sparsa* Young

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3. Aedeagus without a dorsal single process 4
 3'. Aedeagus with a dorsal single process (Figs. 2-3) 5
 4. Aedeagus with a pair of lateral basal processes, branched at apex*A. chocona* Young
 4'. Aedeagus with a pair of lateral medial processes, not branched*A. ordinaria* Young
 5. Aedeagus with two pairs of processes (Fig. 12).....6
 5'. Aedeagus with one pair of processes (Fig. 3).....7
 6. Aedeagus with all processes short, stout (Fig. 12)*A. obtusa* n. sp.
 6'. Aedeagus with one pair of processes elongate (Fig. 15)*A. lobata* n. sp.
 7. Aedeagus with apical pair of processes narrow, curving ventrad (Figs. 2-3)*A. acuta* n. sp.
 7'. Aedeagus with apical pair of processes thicker (Figs. 6 and 9) 8
 8. Aedeagus with apical pair of processes close to shaft, sinuate (Figs. 5 and 6) ...*A. undulata* n. sp.
 8'. Aedeagus with apical pair of processes fork-like (Figs. 8-9).....*A. forficata* n. sp.

Acrulogonia acuta NEW SPECIES

(Figures 1-3)

Description: Length of male 6.4 mm, females unknown. Similar to *A. fuscinula*, but smaller and with different male genitalia. Male genitalia: Pygofer (Fig. 1) narrowing to nearly pointed apex, with hook-like process on dorsal subapical margin. Plates short, narrow, two-thirds length of pygofer. Style and connective similar to *A. fuscinula*. Aedeagus (Figs. 2-3) tubular, stout, with a single median dorsal process, and a pair of lateral apical processes extending beyond apex of shaft and bent ventrad.

Type Data: Holotype male, Colombia: Vaupés, R.N. Mosiro-Itajura (Caparú), Centro Ambiental, 1°04'S 69°31'W, 60 m., Red, 20-I-I-II-2003, M. Sharkey and D. Arias, M-3387.

Differential Diagnosis: This species is close to *A. fuscinula* but is smaller and does not have the pygofer process bifurcate and has a stout aedeagus with the dorsal process closer to the middle of the shaft.

Acrulogonia undulata NEW SPECIES

(Figures 4-6)

Description: Length of males 5.9-6.1 mm, females 5.9-6 mm. Similar to *A. fuscinula*, but smaller and with different male genitalia. Male genitalia: Pygofer (Fig. 4) narrowing to a hooked apex, with a small ventral apical lobe beneath hooked apex. Plates short, half length of pygofer, narrow. Style and connective similar to *A. fuscinula*. Aedeagus (Figs. 5-6) tubular, bent dorsad near middle of shaft, with a single dorsal process near apex and a pair of lateral apical processes extending just beyond apex of shaft.

Type Data: Holotype male, Colombia: Putumayo, PNN La Paya, Cabaña La Paya, 0°07'S 74°56'W, 320 m., 1-15-XII-2001, Malaise, E. Lozano. M-2795. Paratypes: Two males same data as holotype.

Additional Specimens: Other specimens studied are as follows: one male and one female, same data as holotype, except 1-15-XI-2001, M-2439; one male, same data, except Bocana Mamansoya, 23-IX-2001, Red, M-2092; one female, same data, except Salo Grande, 0°01'S 74°56'W, 330 m., 22-IX-2001, Red, M-2087; one male, same data, except Fca. Charapa, 0°08'S 74°57'W, 330 m., 15-30-X-2001, Malaise, R. Cobete, M-2436; one male, same data, except 26-III-10-IV-2002, Malaise, M-3135; one male, same data, except 12-27IV-2002, M-3147; one male, same data, except, Cabaña Viviano Cocha, 0°07'S 74°56'W, 320 m., Malaise, A. Morales, 1-30-VII-2002, M-3314; one male, same data, except Ressuardo Cecilio Cocha, 0°11'S 74°55'W, 190 m., Malaise, 20-24-I-2003, C. Sermiento, M-3419; and one male, same data, except La Nueva Paya, 0°02'S 75°12'W, 210 m., Malaise, 31-I-3-II-2003, M-3423. All specimens are deposited in the Instituto von Humboldt Collection.

Differential Diagnosis: This species is close to *A. fuscinula* but is smaller and differs in the shape of the pygofer, and the shaft of the aedeagus being stout and bent near the middle of the shaft.

Acrulogonia forficata NEW SPECIES

(Figures 7-9)

Description: Length of male 6.5 mm, females unknown. Similar to *A. fuscinula*, but with different male genitalia. Male genitalia: Pygofer (Fig. 7) narrowing to an apex which has a small hook dorsally and a small lobe ventrally. Plate narrow, short, about two-thirds length of pygofer. Style and connective similar to *A. fuscinula*. Aedeagus (Figs. 8-9) short, stout, gradually curving to apex, with a single median subapical process and a pair of stout lateral apical processes extending beyond apex of shaft.

Type Data: Holotype male, Colombia: Caquetá, Santa Rosita, 1°20'N 76°6'W, 600 m., 22-VII-4-VIII-2000, Malaise, F. Ruales, M-1116

Differential Diagnosis: This species is close to *A. fuscinula* but differs in the shape of the pygofer, and the large apical processes of the aedeagus.

Acrulogonia obtusa NEW SPECIES

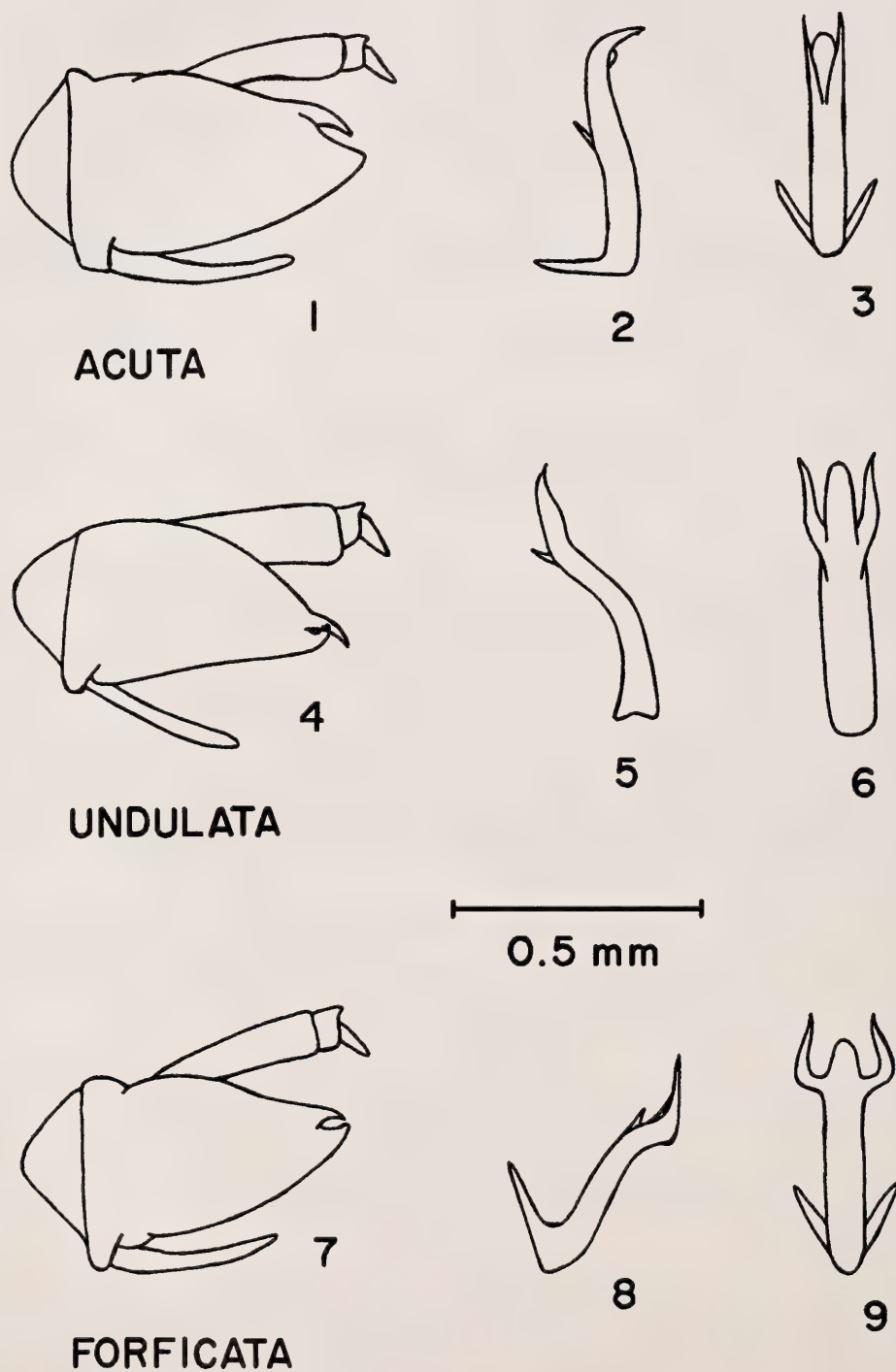
(Figures 10-12)

Description: Length of males 6.1-6.6 mm, females 6.2 mm. Similar to *A. resima*, but with different male genitalia. Male genitalia: Pygofer (Fig. 10) narrowing to a prolonged dorsal process with a ventral narrow lobe beneath. Plate narrow, short, less than half length of pygofer. Style and connective similar to *A. resima*. Aedeagus (Figs. 11-12) straight, tubular, with expanded apex bearing a short single dorsal process and a pair of lateral short slender processes as well as a pair of lateral ventral short stout processes.

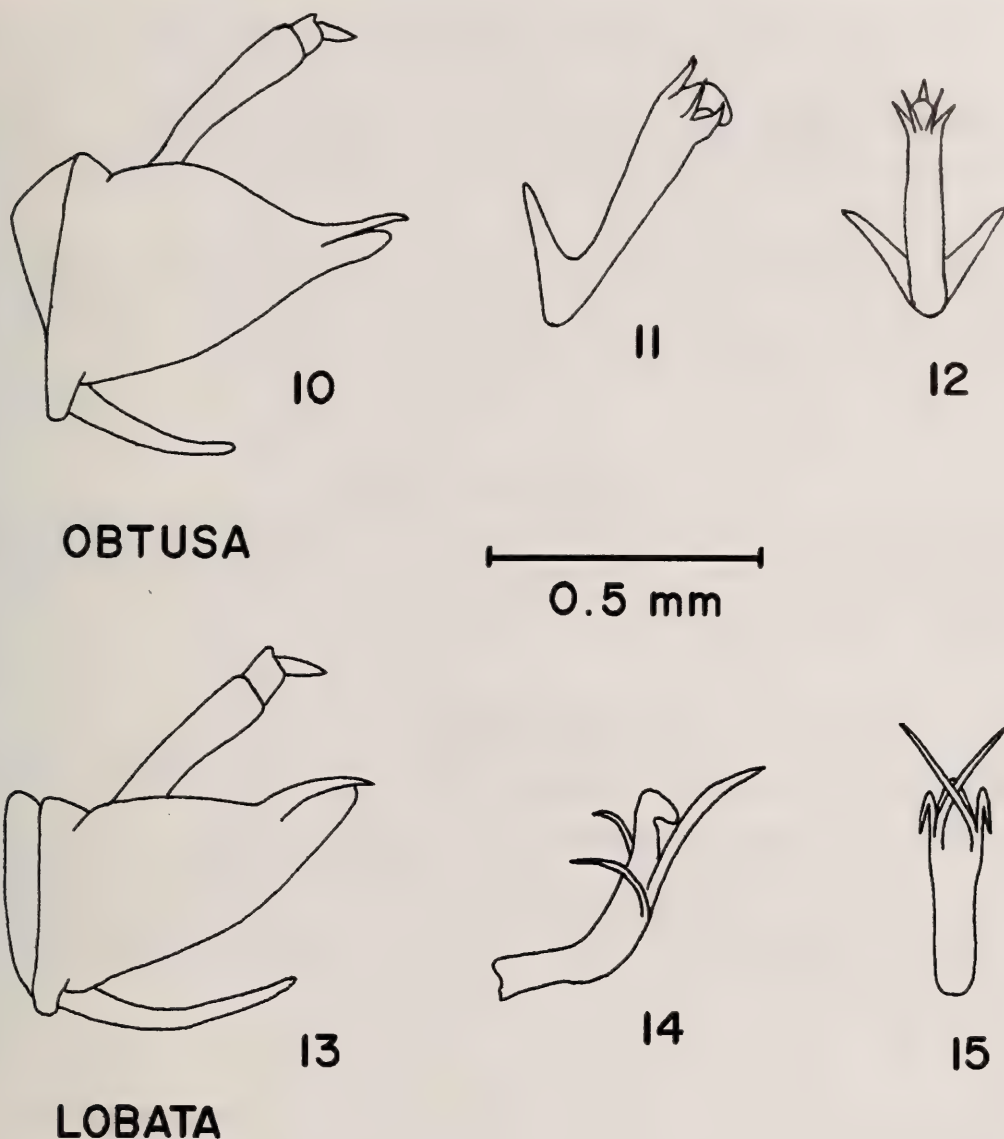
Type Data: Holotype male, Colombia: Vaupés, R.N. Mosiro-Itajura (Caparú), Centro Ambiental, 1°04'S 69°31'W, 60 m., FIT, 20-I-1-II-2003, M. Sharkey and D. Arias, M-3388.

Additional Specimens: One male, 2 females, Colombia: Caquetá, PNN Chiribiquete, Cunare-Amu, 0°12'N 72°25'W, 300 m., 14-17-II-2001, Malaise, M. Ospina and E. González; one male, same data, except 19-22-II-2001; one male same data, except 23-26-II-2001; one male same data, except 28-III-3-IV-2001; one male same data, except Rio Cunare, 0°32'N 72°37'W, 300 m., 15-19-XI-2000, Malaise, E. González and M. Ospina; one male, same data, except 1-5-XI-2000; one male, same data, except Puerto Abeja, 0°04'N 72°26'W, 250 m., 29-X-12-XI-2000, Malaise, J. Forero, M-955; and one male, same data, except 12-26-XI-2000, M-956. All specimens are deposited in the Instituto von Humboldt Collection.

Differential Diagnosis: This species differs from *A. resima* in having a different pygofer apex, and an aedeagus with shorter, more apical processes.



Figures 1-3. *Acrulogonia acuta* n. sp. Fig. 1. Male genital capsule, lateral view. Fig. 2. Aedeagus, lateral view. Fig. 3. Aedeagus, ventral view. Figures 4-6. *A. undulata* n. sp. Fig. 4. Male genital capsule, lateral view. Fig. 5. Aedeagus, lateral view. Fig. 6. Aedeagus, ventral view. Figures 7-9. *A. forficata* n. sp. Fig. 7. Male genital capsule, lateral view. Fig. 8. Aedeagus, lateral view. Fig. 9. Aedeagus, ventral view. All drawn to the same scale.



Figures 10-12. *Acruilogonia obtusa* n. sp. Fig. 10. Male genital capsule, lateral view. Fig. 11. Aedeagus, lateral view. Fig. 12. Aedeagus, ventral view. Figures 13-15. *A. lobata* n. sp. Fig. 13. Male genital capsule, lateral view. Fig. 14. Aedeagus, lateral view. Fig. 15. Aedeagus, ventral view. All drawn to the same scale.

Acruilogonia lobata NEW SPECIES (Figures 13-15)

Description: Length of males 6.2-6.5 mm, females 6.2-6.5 mm. Similar to *A. resima*, but with different male genitalia. Male genitalia: Pygofer (Fig. 13) narrowing to a pointed apex, with a dorsal apical hook-like process. Plate narrow, about half length of pygofer. Style and connective similar to *A. resima*. Aedeagus (Figs. 14-15) stout, tubular with a single slender dorsal curved subapical process, and a pair of longer slender curved lateral ventral processes and a pair of longer ventral processes extending beyond apex of shaft.

Type Data: Holotype male, Colombia: Amazonas, PNN Amacayacu, Cabaña Lorena, 3°00'S 69°59'W, 210 m., 27-VIII-2001, Red, D. Campos, M-2234. Paratypes: Four males and five females, same data as holotype.

Additional Specimens: Other specimens seen are as follows: seventeen males and seventeen females, same data as holotype; and three females, same data as holotype, except 31-VIII-2001, pan trap, M-2204. All specimens are deposited in the Instituto von Humboldt Collection and the University of Kentucky Collection.

Differential Diagnosis: This species differs from *A. resima* in having a different apex on the pygofer, and a similar type of aedeagus, except the lateral processes are not bifurcate and the ventral pair are thicker.

ACKNOWLEDGMENTS

Thanks are extended to Michael J. Sharkey, Department of Entomology, University of Kentucky, who made it possible to study the specimens used in this study through his National Science Foundation Grant no. DEB 0205982.

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SCIENTIFIC NOTE

NEW DISTRIBUTIONAL RECORDS FOR *NICROPHORUS MARGINATUS* FABRICIUS (COLEOPTERA: SILPHIDAE) FROM JALISCO, MEXICO¹Edith García-Real,² Luis Eugenio Rivera-Cervantes,² and Carlos Palomera-García²

The Silphidae, or carrion beetles, are predominantly necrophagous on vertebrate carcasses both in their larval and adult stages. Notable exceptions are *Dendroxena* and *Silpha*, which are predators, and some species of the genus *Aclypea*, which are phytophagous (Navarrete-Heredia and Fierros-López, 2000). Silphid beetles are an important group in forest ecosystems because they recycle and remove substrates that are otherwise key resources for the development of noxious insects, such as flies (Anderson and Peck 1985). However, their role in the carrion-feeding cycle is remarkably less evident in tropical than in temperate regions (Peck and Anderson, 1985).

In Mexico, the Silphidae is comprised of four genera and eleven species, of which four have been accurately recorded for the Mexican state of Jalisco. Sampling in various vegetation types have shown that *Oxelytrum discicolle* (Brullé) 1840, *Thanatophilus truncatus* (Say) 1823 and *Nicrophorus olidus* Matthews 1888 are repeatedly found in Mexican tropical forests. However, in Mexican temperate forests of oak, pine-oak, pine or cloud forests, species composition varies depending on the geographic location and altitude. Various combinations of the same three species are found, along with *N. mexicanus* Matthews 1888 (Rivera-Cervantes and García-Real, 1998; Navarrete-Heredia and Fierros-López, 2000; Fierros-López and Navarrete-Heredia, 2001).

Nicrophorus marginatus Fabricius 1801 belongs to the *marginatus* species group *sensu* Peck and Anderson (1985). This species group is defined by the presence of yellow hairs on the posterior lobe of the metepimeron. *N. marginatus* is currently known in Mexico from the states of Coahuila, Durango, Distrito Federal, Puebla, Veracruz and Hidalgo (Peck and Anderson, 1985; Navarrete-Heredia, 2001).

We provide new distributional data and field observations for *Nicrophorus marginatus*, trapped on the northeastern slope of the Nevado de Colima National Park (2100 m), Jalisco, Mexico.

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RESULTS AND DISCUSSION

We have been trapping invertebrates using carrion trap (model NTP-80, designed by Morón and Terrón, 1984) in the mountains of southern Jalisco, in western Mexico during the last 15 years. The specimens reported here were collected in oak forest on slopes of the Nevado de Colima National Park (2100 m). One carrion trap, with squid as bait, was used and checked monthly from January to December 1997. This area is dominated by oak (Fagaceae) - pine (Pinaceae) forests, with *Quercus castanea*, *Q. laurina*, *Q. rugosa* and *Pinus pseudostrobus* being the most common species (González-Villareal and Pérez de la Rosa, 1987).

N. marginatus was caught with three other carrion beetles: *N. olidus*, *N. mexicanus*, and *Thanatophilus truncatus*. It was the third most abundant species after *N. mexicanus* and *N. olidus* (Fig. 1). The specimens were trapped from July through November 1997, except for October, which suggests a seasonal phenology. At this locality, the most abundant species was *N. mexicanus*, as was found by Rivera-Cervantes and García-Real (1998), as well as Fierros-López and Navarrete-Heredia (2001). It is important to note that *N. marginatus* was not reported by Fierros-López and Navarrete-Heredia (2001) in their 2200 - 3000 m altitudinal gradient study in the northwestern slope of the Nevado de Colima between April to October 1998, which was close to our sampling sites

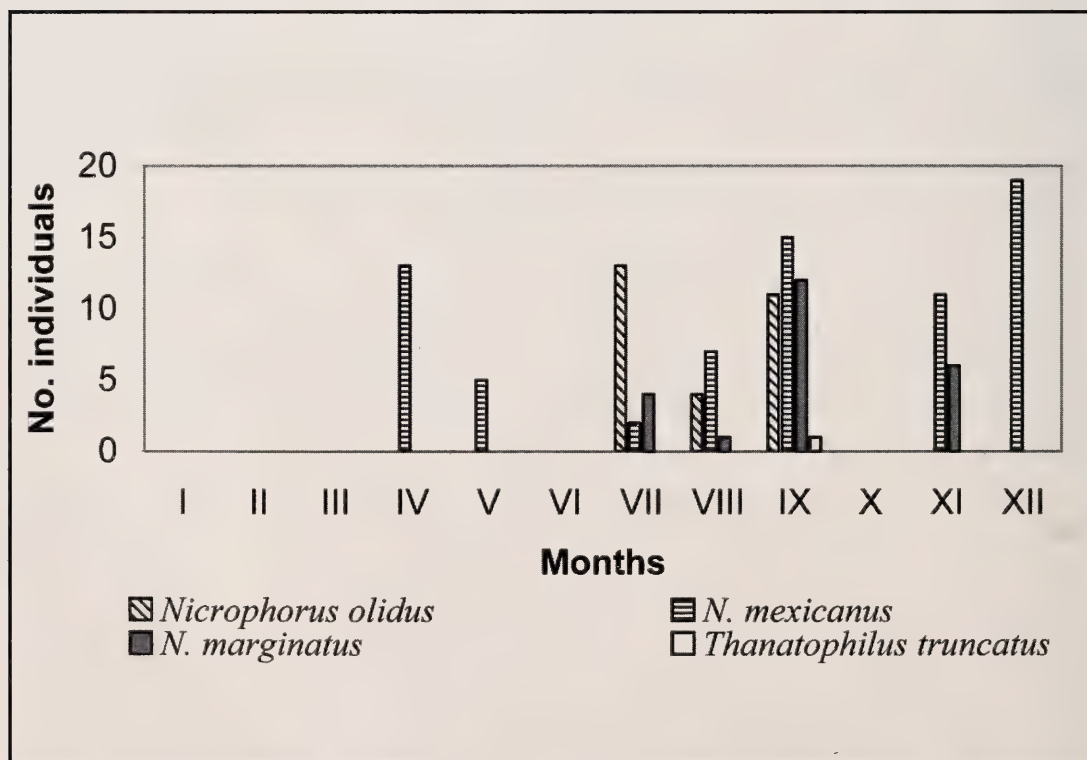


Figure 1. Abundance of Silphidae species trapped in oak (Fagaceae) forest in 1997, Piedra Ancha (2,100m), Jalisco, Mexico.

With this new record for *N. marginatus*, we extend the distribution of this little known but apparently widespread species in Mexico (Fig. 2). Its presence in western Mexico suggests that its distribution pattern follows that of temperate forests (pine, pine-oak, and oak) above 2000m in the Sierra Madre Occidental and the TransVolcanic Belt. Peck and Anderson (1985) mention this species from open habitats in northern parts of its distribution. Its scarcity is probably explained by being in the southern limits of its distribution. Ratcliffe (1996) mentions that this species is widely distributed in North America, and in Mexico it is found only in the north. Moreover, we also believe that the Mexican carrion beetle community is dominated in numbers and phenology by *N. mexicanus* and *N. olidus*.

Material examined: MEXICO, Jalisco, Zapotlán el Grande. VII-1997. G. Granados, col. Piedra Ancha, Oak forest, altitude 2100m, Necrotrap (4 specimens); same collection data, except VIII-1997 (1 specimen); same collection data, except IX-1997 (12 specimens); same collection data, except XI-1997 (6 specimens). All specimens are deposited in the entomological collection of the Instituto Manantlan de Ecología y Conservación de la Biodiversidad, Universidad de Guadalajara. In addition, a new record from Ojuelos is also added: Presa El 40, xerophilous shrub, 2002 m, 21°31'29" N 101°43'43" W, ex NTP squid, Navarrete-Heredia and G.A. Quiroz-Rocha, det. J.L. Navarrete-Heredia 2004. The specimen caught corresponds to a completely different vegetation type than the one reported by us.

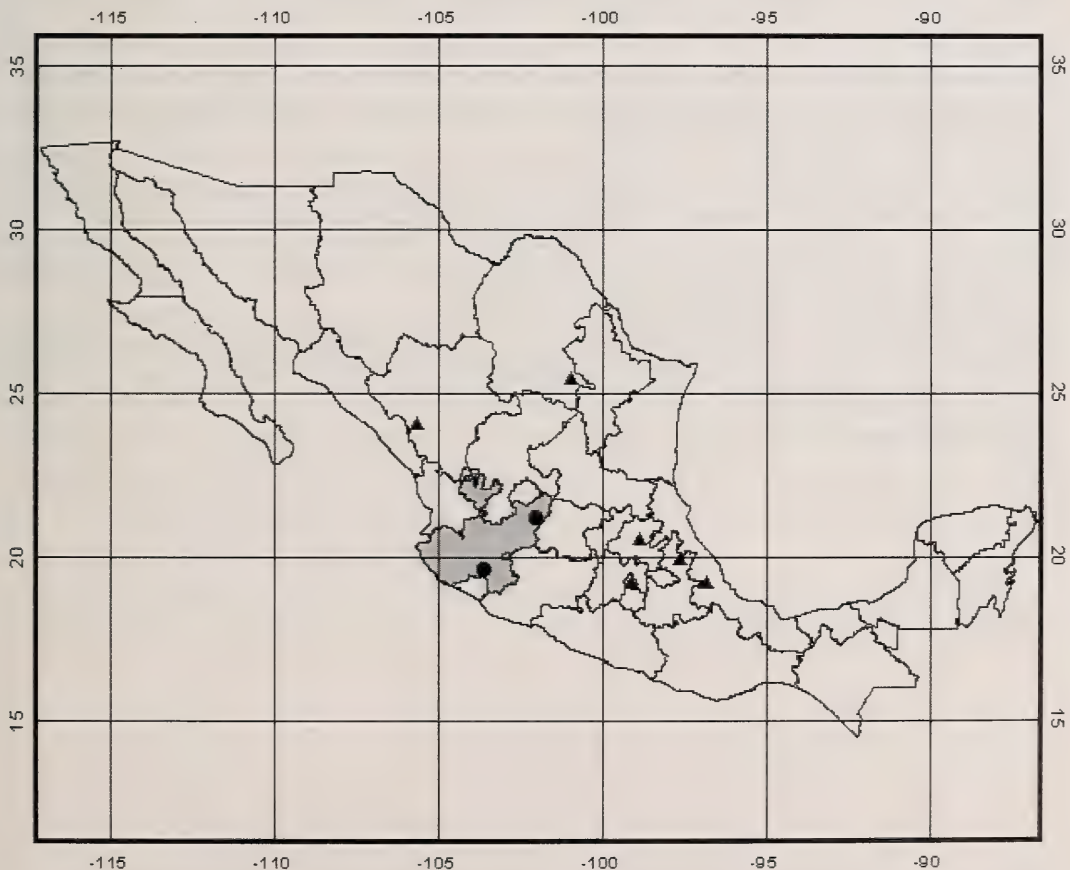


Figure 2. Localities where *Nicrophorus marginatus* has been collected in Mexico. The circles show new records in the state of Jalisco.

ACKNOWLEDGEMENTS

We thank Ingeniero Gerardo Granados for collecting the field samples and the Centro Universitario de la Costa Sur, University of Guadalajara for financing the field trips. We also thank José Luis Navarrete-Heredia from the Centro Universitario de Ciencias Biológicas y Agropecuarias, Universidad de Guadalajara for the information given for this species record in northern Jalisco, as well as to three anonymous reviewers. Raquel Álvarez and Oscar E. Balcazar helped with the maps.

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SCIENTIFIC NOTE

NEBRASKA, U.S.A.: A NEW STATE RECORD FOR THE
SHORTWING SNOWFLY, *ALLOCAPNIA VIVIPARA*
(PLECOPTERA: CAPNIIDAE)¹Robert E. Zuellig² and Boris C. Kondratieff³

The snowfly genus *Allocapnia* is considered an eastern deciduous forest associated group of stoneflies (Ross and Ricker 1971). Currently, 43 species are recognized (Kondratieff and Kirchner 2000). Rhodes and Kondratieff (1996) listed nine stonefly species from the western part of Nebraska. The eastern part of the state was not treated. During a recent survey of the stoneflies of Missouri, one *Allocapnia vivipara* (Claassen) male was collected in eastern Nebraska near the borders of Missouri, Kansas, and Iowa. It is not surprising that *A. vivipara* was found in Nebraska as it has been reported from the adjoining states of Missouri (Poulton and Stewart 1991, Ross and Ricker 1971, Frison 1942), Kansas (Stewart and Huggins 1977, Ross and Ricker 1971, Frison 1942), and Iowa (Heimdal et al. 2004, Ross and Ricker 1971, Frison 1942). Poulton and Stewart (1991) indicated that *A. vivipara* was common in the lowland areas of the Mississippi-Missouri River subregions of Missouri and the Illinois Ozarks. During this survey we also collected *A. vivipara* from several localities in northwestern Missouri. The Illinois Natural History Survey stonefly collection also holds several records of *A. vivipara* from northeastern Missouri. It is likely that additional collections of *A. vivipara* will be made in more northern parts of eastern Nebraska, especially from small tributaries of the Missouri River. Ross and Ricker (1971) indicated that *A. vivipara* is typically found in streams heavily loaded with organic material and is especially tolerant of "barnyard pollution." Poulton and Stewart (1991) reported a similar association of this species with organic enrichment. The stream localities visited during this survey drain mostly row crop agricultural lands typical of this part of the United States. Most sites were deeply incised and silt laden. All material collected during this survey was deposited in the C. P. Gillette Museum of Arthropod Diversity at Colorado State University, Fort Collins, Colorado (CSUC).

Material Examined: New State Record: Nebraska: Cass Co., Weeping Water Creek, Hwy 75 north of Nebraska City, 18-III-2004, B. C. Kondratieff, R. E. Zuellig, & M. Garhart, 1 male (CSUC).

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SCIENTIFIC NOTE

FIRST RECORDS OF MALES AND NEW DISTRIBUTION RECORDS FOR TWO SPECIES OF *AGATHIRSLIA* WESTWOOD (HYMENOPTERA: BRACONIDAE)¹

José Isaac Figueroa-De la Rosa,² Michael J. Sharkey,³ and Víctor López-Martínez⁴

Members of *Agathirsia* Westwood are restricted to the arid regions of Mexico and the southwestern United States of America. Twenty-five of the 31 described species are recorded from Mexico and most of these were recently described by Pucci and Sharkey (2004). Mexican species are widely distributed across the country, but are notably absent from the Yucatan Peninsula and lowland areas along the Gulf of Mexico. They are collected principally from July through October (Pucci and Sharkey, 2004; Sánchez and López, 2000).

Descriptions of *Agathirsia minuata* Pucci and Sharkey and *A. tiro* Pucci and Sharkey were based only on female specimens. *A. minuata* was reported from only one specimen collected in New Mexico (USA), and *A. tiro* was reported from only Nuevo León (Mexico) and Texas (USA).

As a part of a revision of *Crassomicrodus*, specimens of *Agathirsia* were mistakenly sent to the senior author from various institutions. From this material we report for first time males of *A. minuata* and *A. tiro* and new distributional data for the two species. The males of both species are similar to females and therefore descriptions are not included here.

The records are based in material deposited in the following collections: American Entomological Institute (AEI) Gainesville, Florida, U.S.A.; California Academy of Sciences (CAS) San Francisco, California, U.S.A.; Canadian National Collection (CNC), Ottawa, Ontario, Canada; Essig Museum of Entomology-University of California (EMEC), Berkeley, California, U.S.A.; Michigan State University (MSU), East Lansing, Michigan, U.S.A.; The Bohart Museum of Entomology, University of California-Davis (UCDC), Davis, California, U.S.A. and the National Museum of Natural History (formerly known as the United States Natural History Museum (USNM), Washington, District of Columbia, U.S.A.

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***Agathirsia minuata* Pucci and Sharkey**

Collection Data: MÉXICO, Chihuahua: 1 ♀, 33 mill N Hidalgo de Parral, 23.viii.1960, Arnaud P. H., Jr., E. S. Ross & D. C. Rentz (CAS); Sonora: 1 ♀ and 1 ♂, 17 mill S Navojoa, 18.viii.1964, Timberlake (USNM). USA, California: 1 ♂, Capinole, L., 2.x.1941, Ross & Bohart (UCDC); New Mexico: 2 ♂, Rodeo, Hidalgo Co., 21.viii.1960, Arnaud P. H. Jr., E. S. Ross & D. C. Rentz (CAS); 1 ♂, 4.8 mill N Rodeo, Hidalgo Co., 4.ix.1961, Hurd P. D. (EMEC); 1 ♂, 18 mill N Cloverdale, 12.viii.1955, Dreisbach R. R. (USNM); 5 ♀ and 4 ♂, Hatch, 30.viii.1974, Townes H. & M. Townes (AEI).

These are the first records of *A. minuata* from Mexico (Chihuahua and Sonora). The Californian specimen represents a new state record for the USA. This information increases, to 26 species, the number of species of *Agathirsia* recorded from Mexico, representing 83 percent of the total number of species.

***Agathirsia tiro* Pucci and Sharkey**

Collection Data: USA, New Mexico: 1 ♂, Ruidoso, Lincoln Co., 4.vii.1961, Eickwort G. C. (MSU); Texas: 1 ♀, Davis Ranch, NW Blanco Co., 23.iv.1959, Mason W. R. M. (CNC); 1 ♂, Sanderson, 28-29.iv.1959, Mason W. R. M. (CNC); 1 ♂, Sullivan City, Hidalgo Co., 10.iv.1976 (CAS).

These data corroborate the original distribution of the species reported by Pucci and Sharkey (2004), southern United States to northeast Mexico. The New Mexico specimen represents a new state record for the USA.

ACKNOWLEDGMENTS

We appreciate the collaboration of the following collection managers, Robert L. Zuparko (CAS and EMEC), John Huber and Henry Goulet (CNC), Gary L. Parsons (MSU), S. L. Heydon (UCDC), and David R. Smith (USNM) for the loan of the material. Our thanks to Jorge Santiago-Blay (Editor of *Entomological News*) and two anonymous referees for their comments that improved the final version of the manuscript. This work was partially supported by the Consejo Nacional de Ciencia y Tecnología (SNI-CONACYT expd. 31351).

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SCIENTIFIC NOTE

**THE FIRST REPORT OF *ONCASTICHUS GOUGHI*
(HYMENOPTERA: EULOPHIDAE):
AN INTRODUCED PEST OF WAXFLOWER
(MYRTACEAE; *CHAMELAUCIUM UNCINATUM*)
FROM SOUTH AMERICA¹**

Michael W. Gates² and Michael E. Schauff²

The Geraldton waxflower, *Chamelaucium uncinatum* Schauer (Myrtaceae) has been an important species for the California cut flower industry since its introduction from Australia in the early 1980s (Redak and Bethke 1994). It has since been cultivated in South America, Japan, South Africa (Roh and Lawson 1996), New Zealand, and Israel (The Plant People and HoneyBunchWax.com). The waxflower is used mainly for cut flower production, valued for its long vase life, but also for cut shoots with flower buds, cut foliage, and flowering pot plants. Most of the initial physiological and horticultural research on this plant was carried out in Israel (1980s) facilitating the rapid development of the plant, a commercial crop currently being grown on ca. 300 ha in Israel (Shillo 1985; Shillo et al. 1985; Halevy 1994). Israel became the main exporter of wax flowers to Europe during the winter months.

The gall-forming wasp, *Oncastichus goughi* Headrick and La Salle (Eulophidae: Tetrastichinae) was described in 1995, at which time its status as a pest of waxflower and subsequent spread was reported (Headrick et al. 1995). Initially reported in the 1980s (Gough and McMahon 1989; Hamlet 1990) the wasp causes galls on the young leaves and stems decreasing the value of the cut flower product and creating quarantine difficulties. This wasp is a problem in certain regions such as Queensland (Australia), California (USA), and Israel (Considine and Grown 1997). The inquilines and parasitoids of *O. goughi* were apparently co-introduced with *O. goughi* on infested plant material, thus, contributing to a possible decrease in the extent of infestations and economic loss by having accidentally introduced natural mortality factors into California (Headrick, pers. comm. 2004). This may ultimately prove to be the case with new introductions to other countries of this pestiferous wasp.

We report here the identification of *O. goughi* from specimens collected in Peru, the first time the wasp species has been reported in South America. Specimens reared from commercially produced waxflowers at Ica, Peru, on March 18, 2003, by Javier Huanca were sent to the Systematic Entomology

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Laboratory for identification by Clorinda Vergara Cobian from the Departamento de Entomologia y Fitopatologia (Museo de Entomologia, Universidad Nacional Agraria La Molina, Av. La Universidad s/n, Apdo. 456, Lima, Peru). This range expansion indicates that the wasp continues to be transported around the world by human commerce.

ACKNOWLEDGEMENTS

Thanks to Clorinda Vergara Cobian for submitting these specimens to Systematic Entomology Laboratory, ARS, USDA for identification and to Michael Pogue, Alma Solis (Systematic Entomology Laboratory, USDA, ARS, Washington, D.C.) and Gregory Evans (USDA-APHIS, Beltsville, MD) for reviewing earlier versions of this manuscript.

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SCIENTIFIC NOTE

***PATAPIUS SPINOSUS* (ROSSI)
(HEMIPTERA: LEPTOPODIDAE)
IN THE TEXAS PANHANDLE, U.S.A.¹**

W. David Sissom² and James D. Ray³

The leptopodid bug *Patapius spinosus* (Rossi) (Fig. 1) was introduced into the United States from the Old World, having previously been known to occur in Europe, northern Africa, and the Canary Islands. The first record in the United States was at Arbuckle, Colusa County, California (Usinger 1941), based on a single individual taken from traps designed to capture peach twig borer larvae on almond trees. Subsequently, the species was reported from additional localities in California (Drake 1954), in Nevada, and Idaho (Brothers 1979), and more recently from several sites in Washington State (Zack, et al. 2001). *Patapius spinosus* has also been introduced into Chile (Froeschner 1988).



Fig. 1. Adult *Patapis spinosus* (Rossi) (Hemiptera : Leptopodidae).

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While conducting an invertebrate survey at the U.S. Department of Energy/National Nuclear Security Administration's (DOE/NNSA) Pantex Plant in Carson County, Texas, in 2000-2001, we encountered four specimens of this unusual bug in pitfall traps. The plant is located approximately 11.76 km northwest of the intersection of Interstate Highway 40 and Farm to Market Road 2373. Two pitfall trap series were set up along a playa edge (a single line of 10 traps) and the gently sloping (circa 5°) adjoining grassland habitat (a grid of five traps in two rows). One *Patapius* specimen was collected between August 17-24 along the playa edge, and three more were taken between October 13-27 from the grassland site. GPS coordinates for the ends of the playa edge trap line were 35° 19' 08.56", 101° 35' 22.29" and 35° 19' 06.08", 101° 35' 20.90"; the coordinates for the corners of the grassland trap grid were: 35° 19' 10.42"N, 101° 35' 25.57"W; 35° 19' 10.88"N, 101° 35' 27.12"W; 35° 19' 11.14"N, 101° 35' 27.00"W; and 35° 19' 10.65"N, 101° 35' 25.53"W. Although the site was monitored in the spring and summer seasons of two years, the hemipterans appeared only at the end of the second year's sampling.

Vegetation along the playa edge included sunflowers (*Helianthus annuus* L., Asteraceae), creeping spike rush (*Eleocharis macrostachya* Britt, Cyperaceae), woolly-leaf bursage (*Ambrosia grayi* [A. Nels.] Shinnars, Asteraceae), spotted primrose (*Oenothera canescens* Torr. & Frém, Onagraceae), woolly plantain (*Plantago patagonica* Jacq., Plantaginaceae), little barley (*Hordeum pusillum* Nutt., Poaceae), and prickly lettuce (*Lactuca serriola* L., Asteraceae). Vegetation at the grassland site consisted primarily of dense, medium-height grasses, predominantly silver bluestem [*Bothriochloa laguroides* (Herter), Poaceae], prickly pear (*Opuntia macrorhiza* Engelm., Cactaceae), a few soapweed yuccas (*Yucca glauca* Nutt., Agavaceae), a single small Siberian elm tree (*Ulmus pumila* L., Ulmaceae), scurfy pea (*Psoralea tenuiflora* Pursh, Fabaceae), western ragweed (*Ambrosia psilostachya* DC, Asteraceae), prickly lettuce, curl-cup gumweed (*Grindelia squarrosa* [Pursh] Dun, Asteraceae), devil's claw (*Proboscidea louisianica* [P. Mill.] Thell., Pedaliaceae), and nodding thistle (*Carduus nutans* L., Asteraceae). The grassland adjoining the playa was utilized for cattle grazing in 2001, but the cattle were not introduced until after the July sampling period and were removed before the October period. The effects of the cattle on the vegetation were noticeable during August sampling, and became pronounced by October, with the vegetation cropped low to the ground. The site is devoid of rock cover, and the soil consisted primarily of PEP clay loam.

Previous authors have presented considerable data regarding the habitats in which *Patapius spinosus* has been found. Brothers (1979) reported his specimens from underneath cobblestones in a mine-tailings dump. The Washington sites were also characterized by the presence of cobblestone, and the hemipterans were common among the rocks. One specimen from the Hanford Nuclear Site (Zack et al. 2001) was taken from a pitfall trap set in the vegetated area surrounding an alkaline pond (West Lake). Zack et al. (2001) also found numerous specimens from several sites along the Snake River in Whitman County, Washington; these specimens were also taken from rocky habitats. Our site, as previ-

ously indicated, lacks rocks altogether, and the only types of cover available were cow pies and the relatively sparse litter that accumulates in the grassland.

Froeschner (1988) indicates that leptopodids are typically associated with moist habitats around bodies of water, and this was also observed by Zach et al. (2001). The Brothers (1979) sites, however, were away from sources of water. Our site was adjacent to a playa wetland; however, this basin remained dry throughout most of the study period.

The new Texas record is of considerable interest because it is in the center of the North American continent more than 1700 kilometers southeast of the previously easternmost sites in Nevada. It seems unlikely that the dispersal event was natural, because *Patapius* is a ground dwelling bug with apparently low mobility. Sixty years after its first noted occurrence in California, it still appears to be almost strictly limited to that and a few surrounding states.

The Pantex Plant is a nuclear weapons maintenance and dismantling facility, and it is interesting to note that one of the Washington State sites was the Hanford Nuclear Site (also DOE/NNSA) in Benton County. Transfer of specimens between these DOE/NNSA sites could have occurred, as past and current subcontractors have worked at Pantex as well as on or around the Hanford site, elsewhere in the Pacific Northwest, and in California. We suspect that the introduction to the Pantex Plant is new, because the bug was not taken from any of 10 regularly monitored sites between July 2000 and July 2001.

Three of the Pantex specimens are permanently housed in the Entomology Collection at West Texas A&M University in Canyon, Texas, and the fourth has been deposited in the Entomology Collection at Texas A&M University at College Station.

ACKNOWLEDGMENTS

We are grateful to Dr. Joseph Schaffner of the Entomology Department at Texas A&M University for verifying our identification of *P. spinosus* and supplying pertinent literature. Funding for the collections was provided by the DOE/NNSA in cooperation with BWXT-Pantex, L.L.C. We thank M. Schoenhals and M. Keck of BWXT Pantex, L.L.C. for assistance with site access coordination.

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BOOK REVIEW

SPIDERS OF THE EASTERN UNITED STATES. A PHOTOGRAPHIC GUIDE. W. Mike Howell and Ronald L. Jenkins. 2004. Pearson Education Inc., 75 Arlington St., Boston, MA 02116. 361 pp. 269 color photographs. 43 line drawings. Softcover. ISBN 0-536-75853-0. \$30. Available from BioQuip, Inc; <http://www.bioquip.com>.

Identification guides based on photographs of arthropods in the field concentrate on showy subjects such as Lepidoptera and Odonata more often than on less charismatic creatures such as arachnids. *Spiders of the Eastern United States* demonstrates that a guide presenting photographs of arthropods alive in their natural habitats can succeed even for arachnids. In an attractive presentation, it illustrates and describes 166 species of spiders in 35 families in the eastern United States. The authors selected species primarily according to those most commonly encountered. These species constitute a small fraction of the region's total, which the authors estimate to be from 800 to 2000.

The book is intended for an audience lacking special expertise in arachnid taxonomy, but it will reward anyone interested in identification of the region's spiders. The photographs are superb. They capture individuals exhibiting characteristic behavior, such as the extension of the front legs of the green *Tetragnatha viridis* (Walckenaer), shown camouflaged on needles of a loblolly pine. Habitats included in photographs are revealing, such as a mud dauber's nest where a pirate spider, *Mimetus puritanus* (Chamberlin), is shown ready to steal the wasp's captured prey. Photographs of webs are often as diagnostic as the images of the spiders themselves. The authors have expanded accounts of spiders of particular significance. For example, 8 photographs of individuals in the genus *Lactro-dectus* (black widows and venomous relatives) illustrate differences in appearance among sexes, juveniles, and species. The authors present 40 species of araneids (orbweavers) and 25 species of salticids (jumping spiders). Each species is identified according to family, genus, species, and if present, common name. The authors took all the photographs themselves. They include a photograph of their handheld macrophotography gear, and they give helpful details about their photographic technique.

Introductory chapters include general information about spiders. They briefly discuss spider anatomy; venom; silk; populations; and taxonomy. Schematic drawings illustrate distinguishing features of the cephalothorax for 31 families of spiders. In the accounts of individual species, the authors describe appearance, ecology, and behavior. The organization of taxons begins with mygalomorphs and ends with salticids. The book concludes with a glossary, bibliography, and index of species alphabetized according to genus. Unfortunately, common and species names are not indexed.

This book frequently cites Kaston's *Spider's of Connecticut* (1981) which, although published over two decades ago, remains the most comprehensive reference on spiders for the region. Kaston's work contains no color photographs and presumes that the reader has familiarity with spider systematics. For those who want help identifying species of spiders that they are most likely to encounter in the eastern United States, Howell and Jenkins have provided an informative and esthetically pleasing introduction.

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Virgin Tiger Moth – *Grammia virgo* (Linnaeus) (Lepidoptera: Arctiidae)
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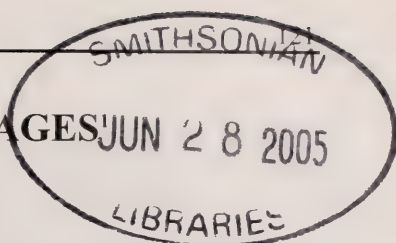
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HEMIPTERA AS CECIDOPHAGES

Kazuo Yamazaki² and Shinji Sugiura³



ABSTRACT: Gall-feeding by non-gallmaking insects (cecidophagy) has been recorded mostly for Lepidoptera, Coleoptera and Hymenoptera, but rarely for Hemiptera. We report here seven observations of cecidophagy in Japanese Hemiptera: *Carbula humerigera* (Uhler) (Pentatomidae) on a gall midge gall; *Halyomorpha picus* (Fabricius) (Pentatomidae) on a gall wasp gall; *Plautia crossota stali* Scott (Pentatomidae) and *Megacopta punctatissima* (Montandon) (Plataspidae) on an aphid gall; *Geisha distinctissima* (Walker) (Flatidae) on a clearwing moth gall; *Planococcus kraunhiae* Kuwana (Pseudococcidae) on a bacterium gall; and *Chaitophorus saliniger* Shinji (Aphididae) in a sawfly gall. These hemipterans feed on galls because they are sinks for assimilates and have more nutritious phloem sap and parenchyma than do normal plant tissues.

KEY WORDS: Heteroptera, Homoptera, galls, cecidophagy, adaptive significance

Plant galls are formed by physicochemical stimuli produced by a wide variety of organisms, including insects, mites, nematodes, fungi, viruses and bacteria (e.g., Mani 1964; Meyer 1987), and provide gall-makers with nutritious tissues, a mild microclimate and occasionally shelter from natural enemies (Price et al. 1987). Galls are therefore inhabited by predators, parasitoids, cecidophages and successori, resulting in diverse communities on galls. Gall-centered insect communities have been studied from the viewpoint of community ecology (e.g., Yukawa 1983; Hawkins and Goeden 1984; McGeoch and Chown 1997). Among the community components, cecidophages (non-gallmaking gall-feeders) have been recorded primarily in Lepidoptera (e.g., Abe 1997; McGeoch and Chown 1997; Yamazaki and Sugiura 2003), Coleoptera (e.g., Clancy 1993; Sugiura et al. 2004) and Hymenoptera (e.g., Stone et al. 2002), but rarely in Hemiptera (but see Pepper and Tissot 1973; Yang et al. 2001; Miller and Crespi 2003). In this report, we described the cecidophagous habits of seven hemipteran species observed in central Japan.

METHODS

Galls examined. We observed cecidophagous Hemiptera on the following six galls in Osaka and Kyoto Prefectures in central Japan. Common names of galls and species identification of the gall-makers were based on Yukawa and Masuda (1996).

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1) Oval stem galls made by the gall midge *Lasioptera achyranthii* Shinji (Diptera: Cecidomyiidae) on the herb *Achyranthes bidentata* var. *japonica* (Amaranthaceae); 2) oval bud galls made by the gall wasp *Dryocosmus kuriphilus* Yasumatsu (Hymenoptera: Cynipidae) on the chestnut tree *Castanea crenata* (Fagaceae); 3) irregular pouch leaf galls made by the aphid *Schlechtendalia chinensis* (Bell) (Homoptera: Aphididae) on the shrub *Rhus javanica* (Anacardiaceae); 4) fusiform stem galls made by the clearwing moth *Paranthrene pernix* (Leech) (Lepidoptera: Sessidae) on the vine *Paederia scandens* (Rubiaceae); 5) irregular oval trunk galls produced by the bacterium *Pantoea agglomerans* pv. *milletiae* (Ewing and Fife) Gavini et al. (Enterobacteriaceae) on the vine *Wisteria floribunda* (Leguminosae); and 6) roll leaf galls induced by the sawfly *Phyllocolpa* sp. (Hymenoptera: Tenthredinidae) on the tree *Salix eriocarpa* (Salicaceae).

RESULTS

The observations made are summarized in Table 1 and the details are as follows:

- 1) We found a *Carbula humerigera* (Uhler) (Heteroptera: Pentatomidae) adult sucking on a *L. achyranthii* gall alongside a hiking route in Amami (34°23'N, 135°35'E, ca. 300 m above sea level, a.s.l.), Kawachinagano City, Osaka on August 13, 2001. The multichambered gall was formed in a stem node and was ca. 20 mm in diameter. *Carbula humerigera* was abundant on various asteraceous herbs and rosaceous shrubs, whose stems and flowers *C. humerigera* fed on the sap, on the forest floor.
- 2) A *Halyomorpha picus* (Fabricius) (Heteroptera: Pentatomidae) adult was observed sucking on a *D. kuriphilus* gall in the Kamigamo Experimental Forest of Kyoto University (35°4'N, 135°45'E, ca. 150 m a.s.l.), Kyoto City on May 14, 2004 (Figure 1A). The buds of chestnuts had swelled to form galls and the gall diameter was ca. 15 mm.

Table 1. Cecidophagous hemipterans on six galls in Osaka and Kyoto, central Japan.

Hemipterans		Gall-makers	Host plants
FAMILY	SPECIES	FAMILY	SPECIES
(1) Pentatomidae	<i>Carbula humerigera</i>	Cecidomyiidae	<i>Lasioptera achyranthii</i> , <i>Achyranthes bidentata</i>
(2) Pentatomidae	<i>Plautia crossota stali</i>	Aphididae	<i>Schlechtendalia chinensis</i> , <i>Rhus javanica</i>
Plataspidae	<i>Megacoptera punctatissima</i>		
(3) Pentatomidae	<i>Halyomorpha picus</i>	Cynipidae	<i>Dryocosmus kuriphilus</i> , <i>Castanea crenata</i>
(4) Flatidae	<i>Geisha distinctissima distinctissima</i>	Sessidae	<i>Paranthrene pernix</i> , <i>Paederia scandens</i>
(5) Pseudococcidae	<i>Planococcus kraunbiae</i>	Enterobacteriaceae	<i>Pantoea agglomerans</i> , <i>Wisteria floribunda</i>
(6) Aphididae	<i>Chaitophorus saliniger</i>	Tenthredinidae	<i>Phyllocolpa</i> sp., <i>Salix eriocarpa</i>

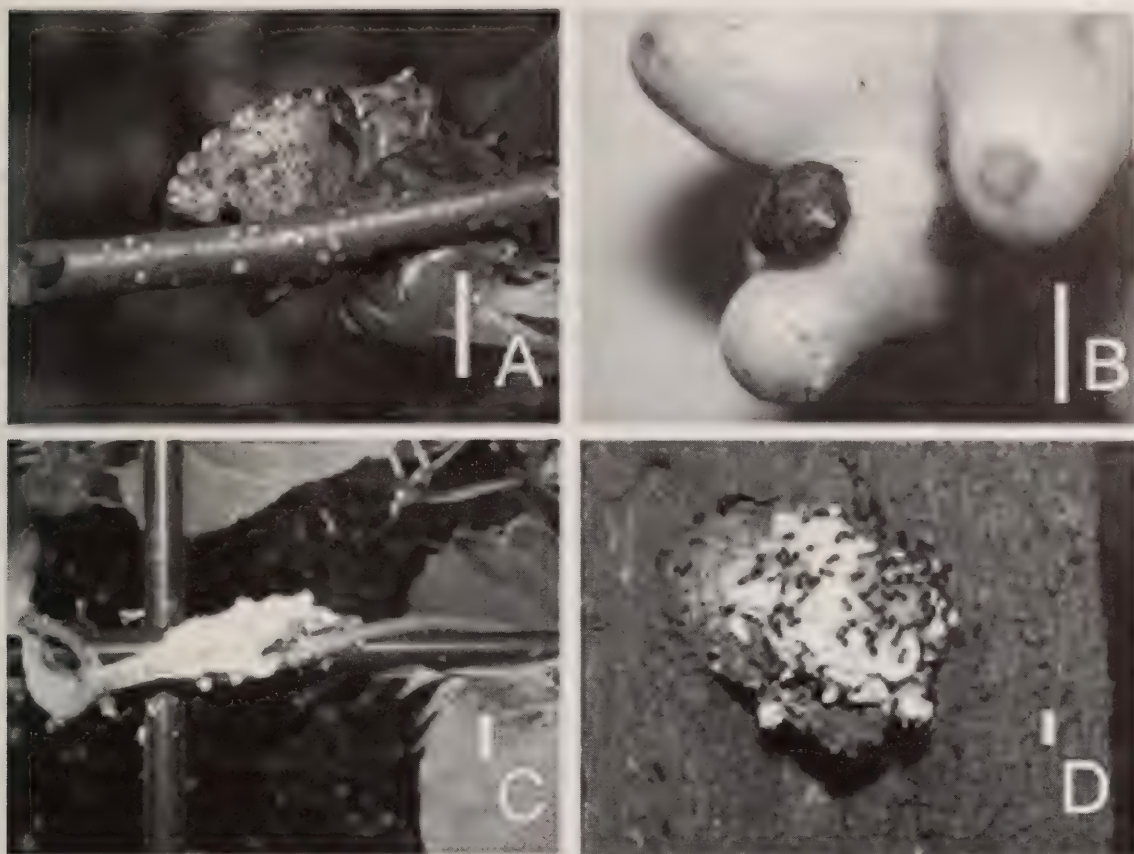


Figure 1. Gall-feeding Hemiptera observed in central Japan. A. *Halymorpha picus* adult on a *Dryocosmus kuriphilus* gall. B. *Megacoptera punctatissima* adult feeding on a *Schlechtendalia chinensis* gall. C. *Geisha distinctissima* nymphs covered with white waxy threads sucking a *Paranthrene pernix* gall. D. *Planococcus kraynhiae* females coated with white waxy threads on a *Pantoea agglomerans* pv. *milletiae* gall. *Pristomyrmex pungens* ants attending mealybugs. Scale bars = 5mm.

3) A *Plautia crossota stali* Scott (Heteroptera: Pentatomidae) and two *Megacoptera punctatissima* (Montandon) (Heteroptera: Plataspidae) adults were observed sucking on a *S. chinensis* gall alongside a hiking route in Toukiyama (34°24'N, 135°32'E, ca. 140 m a.s.l.), Osaka-sayama City, Osaka on October 16, 2003 (Figure 1B). The aphid gall was large (ca. 50 mm in length), had been formed on a petiole of a compound leaf of the host plant, and was irregularly-shaped, with a large surface area. From the surface of a small number of *S. chinensis* galls, tar-like resin was being exuded, suggesting heteropteran sucking damage to the galls. A few *P. crossota stali* were found on the leaves of broad-leaved deciduous trees, and many *M. punctatissima* bugs were present on the stems of leguminous plants, indicating facultative gall use as food resources.

4) Seven *Geisha distinctissima* (Walker) (Homoptera: Flatidae) nymphs, which were coated with waxy threads, had settled on four *P. pernix* galls in Tannowa (34°20'N, 135°11'E, ca. 2 m a.s.l.), Misaki-cho, Osaka on July 16, 2004 (Figure 1C). The fusiform galls were formed in the stems of the host plant, and their sizes were ca. 30 mm in length and ca. 10mm in diameter. These flatid

nymphs appeared to be sucking on the galls, because the waxy threads were strongly attached to the gall surfaces, indicating settlement for an extended period and feeding activity. *Geisha distinctissima* were not observed on normal shoots of the host plant. Therefore, the nymphs may prefer the galls to the normal shoots. We could not find any physical damage to the galls inflicted by *G. distinctissima*.

5) A large colony of the Japanese mealybug *Planococcus kraunhiae* Kuwana (Homoptera: Pseudococcidae) was found on each of two bacterial galls formed by *P. agglomerans* pv. *milletiae* at an urban Park in Suminoe (34°36'N, 135°29'E, ca. 5 m a.s.l.), Osaka City on July 18, 2004 (Figure 1D). The oval galls were formed in a *Wisteria* trunk and were ca. 50 mm in diameter. The colonies were not found on the normal parts of the trunks and twigs of the host plant. Thus, the mealybug female adults appear to prefer the galls to the trunks and twigs. Ants, *Pristomyrmex pungens* Mayr, were attending the mealybugs. We could not find any physical damage on the galls attributable to the mealybugs.

6) Many *Chaitophorus saliniger* Shinji (Homoptera: Aphididae) colonies were found in galls induced by *Phyllocolpa* sawflies along a riverbank (34°53'N, 135°42'E, ca. 10 m a.s.l.) of the Kizu River in Kyoto on April 25, 2002. The elongate willow leaf had been longitudinally rolled to form a gall 40 - 50 mm in length. Aphid colonies had formed on inner surfaces of the leaf roll, and the aphids were feeding on the rolls and appeared to be parthenogenetically proliferating in them. No parasitized aphid mummies were found in the galls, but several mummies in the aphid colonies on the undersides of normal leaves were seen. There was no visible physical damage to the galls caused by the aphids.

DISCUSSION

Although herbivorous sap feeders (mainly Hemiptera: Homoptera and Thysanoptera) as gall-makers have frequently been studied, those as cecidophages have rarely been investigated except for in the studies by Pepper and Pissot (1973), Crespi et al. (1997), Yang et al. (2001) and Miller and Crespi (2003). Here we document hemipteran cecidophagy in various settings: Cecidophages belonged to five families of Heteroptera and Homoptera; the gall-maker taxa consisted of five insect families of four orders and a bacterium; the growth forms of the host plants contained herb, vines, shrub and trees; and the host plant taxa consisted of six families. Therefore, hemipteran cecidophagy is probably associated with various types of plant galls. These cecidophagous hemipterans are common species in suburban and rural areas of central Japan, and are agricultural pests (Kawai 1980; Moritsu 1983; Tomokuni et al. 1993).

All the types of hemipterans observed in this study feed on the parenchyma and phloem sap of normal plant tissues (Tomokuni et al. 1993; Schoonhoven et al. 1998). Therefore, these hemipterans have been classified as facultative cecidophages, which utilize normal plant tissues as well as gall tissues (sensu Mani

1964). Since plant galls are sinks of assimilates where photosynthates are imported from leaves (sources) and possess a greater amount of nutritious phloem sap and parenchyma than do normal plant tissues (Larson and Whitham 1991; Hartley and Lawton 1992), hemipterans may suck on gall sap as a superior food resource. In addition, galls are more or less swollen structures and have large surface areas, possibly resulting in a comfortable settlement site. In the case of the aphid *C. saliniger*, leaf roll galls of a sawfly might function as refuges from parasitoids, because no parasitized aphid mummies were present in the galls, although several mummies were found on normal leaves. An increase in the number of aphids in the roll galls may have occurred due to the presence of superior phloem sap and the gall structure acting as a refuge.

The feeding damage caused by these hemipterans to the galls appeared to differ between Heteroptera and Homoptera. Heteroptera such as pentatomids and plataspids feed on parenchyma using digestive saliva, while Homoptera such as flatids, mealybugs and aphids suck phloem sap using flexible stylets (Tjallingii and Hogen Esch 1993; Schoonhoven et al. 1998). Therefore, the physical feeding damage caused to galls was prominent for Heteroptera and negligible for Homoptera, although the interception of phloem sap by homopteran cecidophages might have affected the gall-makers living inside the galls.

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DISJUNCT DISTRIBUTIONS OF *PSEUDOPOMALA BRACHYPTERA* AND *CAMPYLACANTHA OLIVACEA* (ORTHOPTERA: ACRIDIDAE) IN THE BLACKLAND PRAIRIES OF MISSISSIPPI, U.S.A.¹

JoVonn G. Hill²

ABSTRACT: Reports of disjunct distributions of two grasshoppers, *Pseudopomala brachyptera* and *Campylacantha olivacea* are given.

KEY WORDS: Disjunct distribution, *Pseudopomala brachyptera*, *Campylacantha olivacea*, Blackland Prairies, Mississippi, U.S.A.

Mississippi has two physiographic regions characterized by prairie, the Black Belt Prairie and the Jackson Prairie (Figure 1). The Black Belt Prairie is a crescent-shaped region that extends from McNary County in southern Tennessee through east-central Mississippi to Russell County, Alabama, near the Georgia border (Lowe, 1921; Smith, 1926; Stephenson and Monroe, 1940; Schiefer, 1998). The Black Belt is underlain by Cretaceous Selma chalk that is composed of fossiliferous, soft, white-gray limestone that weathers into fertile black soil for which the region is named (Logan, 1903; Lowe, 1913; Stephenson and Monroe, 1940; Hicks and Haynes, 2000).

Floristic surveys of the prairies in the Black Belt have revealed a distinct plant community that is similar to that of the Great Plains (Schuster and McDaniel, 1973; MacDonald, 1996; Leidolf and McDaniel, 1998). The most common grasses (Poaceae) include *Bouteloua curtipendula* (Michx.) Torr., *Panicum virgatum* L., *Schizachyrium scoparium* (Michx.) Nash, and *Sorghastrum nutans* (L.) Nash. Prominent forbs include *Asclepias viridis* Walter (Asclepladaceae), *Dalea candida* (Michx.) Willd., *D. purpurea* Vent. (Fabaceae), *Liatris squarrosa* (L.) Michx., *L. squarrulosa* Michx. (Asteraceae), *Ratibida pinnata* (Vent.) Barnh. (Asteraceae), *Silphium laciniatum* L., and *S. terebinthinaceum* Jacq. (Asteraceae).

The Jackson Prairie extends eastward from central Mississippi to just across the Alabama line into Washington County. The soils of this region, like those in the Black Belt, are formed from fossiliferous chalk that weathers into a dark rich soil (Moran et al., 1997).

The Mississippi Entomological Museum (MEM) has been surveying the insect fauna of the prairie regions of the state since the late 1980s. These surveys have documented populations of the bee, *Tetraloniella albata* (Cresson) (Anthophoridae), four species of Cerambycidae, and several species of moths that are disjunct from the Great Plains (MacGown and Schiefer, 1992; Schiefer, 1998; Brown, 2003).

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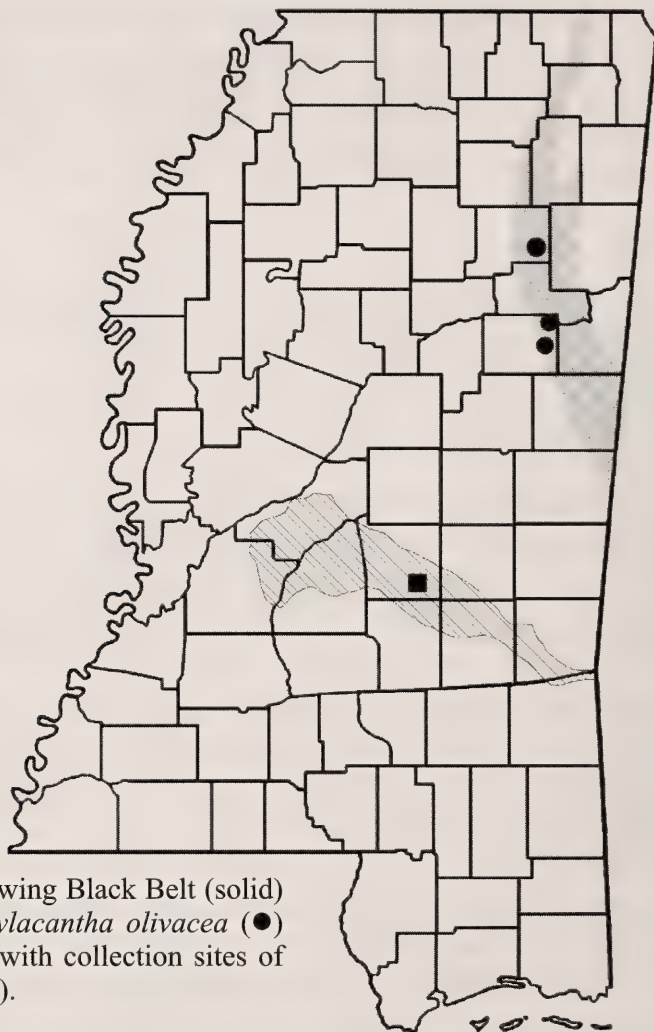


Figure 1. Mississippi map showing Black Belt (solid) with collection sites of *Campylacantha olivacea* (●) and Jackson Prairie (hatched) with collection sites of *Pseudopomala brachyptera* (■).

Recent collections of grasshoppers in prairie regions of the state have documented two additional species with disjunct distributions. Examinations of grasshopper holdings in the University of Mississippi insect collection and MEM have revealed additional records of one of these species in the latter collection. Voucher specimens of newly collected material have been deposited in the MEM collection.

Pseudopomala brachyptera (Scudder)

Otte (1981) reported the distribution of *Pseudopomala brachyptera* as “mainly northern United States and western Canada, but ranging southward through Kansas and Oklahoma.” This species has been reported to be commonly found on Little Bluestem, *Schizachyrium scoparium*, a dominant plant on Mississippi’s prairies (Morse, 1896; Blatchley, 1920). *Pseudopomala brachyptera* was found at only one of the three Jackson Prairie sites that were surveyed, at which it was relatively common. Because of its restricted distribution in Mississippi, only a limited number of voucher specimens were collected.

Mississippi Records. Scott Co.: Pinkston Hill, T5N R9E Sec.17, Jackson Prairie, 30 June 2001 (2 females), 12 July 2003 (2 males, 1 female).

Campylacantha olivacea (Scudder)

The known distribution of *Campylacantha olivacea* extends from Illinois west to Nebraska and southeastern Colorado and south to Fort Worth, Texas, with disjunct populations reported from Macon, Georgia, and Marengo County, Alabama (Rehn and Hebard, 1916; Blatchley, 1920; Dakin and Hays, 1970). It is interesting to note that these disjunct populations, as well as the Mississippi records of *C. olivacea* reported here, all occur on or are associated with blackland prairies. Dakin and Hayes (1970) list two specimens from Marengo County, Alabama, which lies within Alabama's Black Belt and historically contained about 4150 ha of prairie according to surveys made in the 1800s (J. A. Barone, pers. comm.). The older Mississippi specimens are labeled as having been collected at either Agricultural College, or A&M College, both of which are former names for Mississippi State University. Parts of the campus lie at the edge of the Black Belt in Oktibbeha County and still contain prairie features to this day. The most recent specimens from Mississippi were taken on Western Ragweed (*Ambrosia psilostachya* DC.) from a prairie remnant at Osborn, Oktibbeha County. This is consistent with Rehn and Hebard (1916) who state that this species is often very abundant on large ragweeds (*Ambrosia* spp.) in Georgia. Blackland prairie remnants were recently described in Houston and Bleckley counties, which lie just south of Macon, Georgia, near where *C. olivacea* was historically collected (Klaus and Patrick, 2002).

Mississippi Records. Chickasaw Co.: Buena Vista, 4 Aug. 1916 (1 female). Oktibbeha Co.: Agricultural College [Mississippi State University], 19 Aug.-12 Nov., 1914-1931 (13 females); Osborn, 33°30'41"N 88°44'08"W, Black Belt Prairie, 14 Aug. 2001 (1 female), 13 Oct. 2003 Sweeping *Ambrosia psilostachya* DC., Black Belt Prairie (2 males, 1 female).

Another orthopteroid with a disjunct distribution in the Southeast is the Prairie Tree Cricket, *Oecanthus argentinus* Saussure. This species is found in the western United States east to Ohio, with disjunct populations occurring in Alabama and Florida (Helfer, 1971; Walker and Moore, 2004). Dakin and Hays (1970) list *O. argentinus* as a species inhabiting the Black Belt Prairie in Alabama, but this species has not yet been found in Mississippi's Black Belt. The distribution of these three species adds additional support to Brown's (2003) hypothesis that the Black Belt was a refugium for Great Plains species during and after the Wisconsin glaciation (approximately 0.1-0.01 million years ago). Further biogeographical studies are needed to better understand how isolated open habitats in the southeast, such as the Black Belt and Jackson Prairie, are associated with each other and with the Great Plains.

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A NEW SPECIES OF ROBBER FLY OF THE *INSULA* SPECIES GROUP OF *MERODONTINA* ENDERLEIN (DIPTERA: ASILIDAE) FROM VIETNAM¹

Aubrey G. Scarbrough² and Jessica Constantino³

ABSTRACT: A new species of robber fly of the *insula* species group of *Merodontina* Enderlein from Vietnam, *M. bellicosa*, sp. nov., is described, illustrated, and compared with congeners. A key to the regional species of the *insula* species group of *Merodontina*, new locality records of *M. thaiensis* Scarbrough and Hill, and a list of all known species in the genus are included.

KEY WORDS: *Merodontina*, Diptera, Asilidae, Vietnam, new species

The genus *Merodontina* Enderlein (1914) is composed of a small group of *Ommatius*-like robber flies which have a strong dilation of the anterior margin on the apical half of the wing, an acutely pointed first radial cell, and a prominent ventrobasal digitate process on the hind femur of the male. Presently, this genus includes 12 species: five species from India (Joseph and Parui 1998), four from China (Hua 1987, Shi 1991), and three from Southeast Asia (Scarbrough and Hill 2000a, Haupt and Azuma 1997). Based upon our studies of all material except those from China, we recognize two groups based largely on the shapes of the male epandrium. The *sikkim* group is presently limited to India and is characterized by a long, narrow epandrium. The *insula* species group is found in southeastern Asia and Iriomote Island, Japan, and is characterized by an apically capitate epandrium. We describe and illustrate a fourth species of the *insula* group from Vietnam and provide new records of *M. thaiensis* Scarbrough and Hill from Thailand. A list of all known species of the genus and a key to the regional species are also provided.

METHODS

The descriptive terminology and acronyms of museums follow McAlpine (1981) and Arnett et al. (1993), respectively. Specimens for this study were obtained via loans from curators at the following collections: David Grimaldi, American Museum of Natural History, New York (AMNH) and Thomas Pape, Museum of Zoology, University of Copenhagen (ZMUC). Dissection of the terminalia and preparation of illustrations follow Scarbrough and Hill (2000a, b). In recording label data of specimens, each line is denoted by a forward slash (/). All measurements were made of pinned specimens. Structures illustrated in different positions are accompanied by a single scale line.

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Merodontina bellicosa, sp. nov.

Figs 1-6

Male. Body dark brown to black. Measurements, body 21.2 mm; wing 16.7 mm.

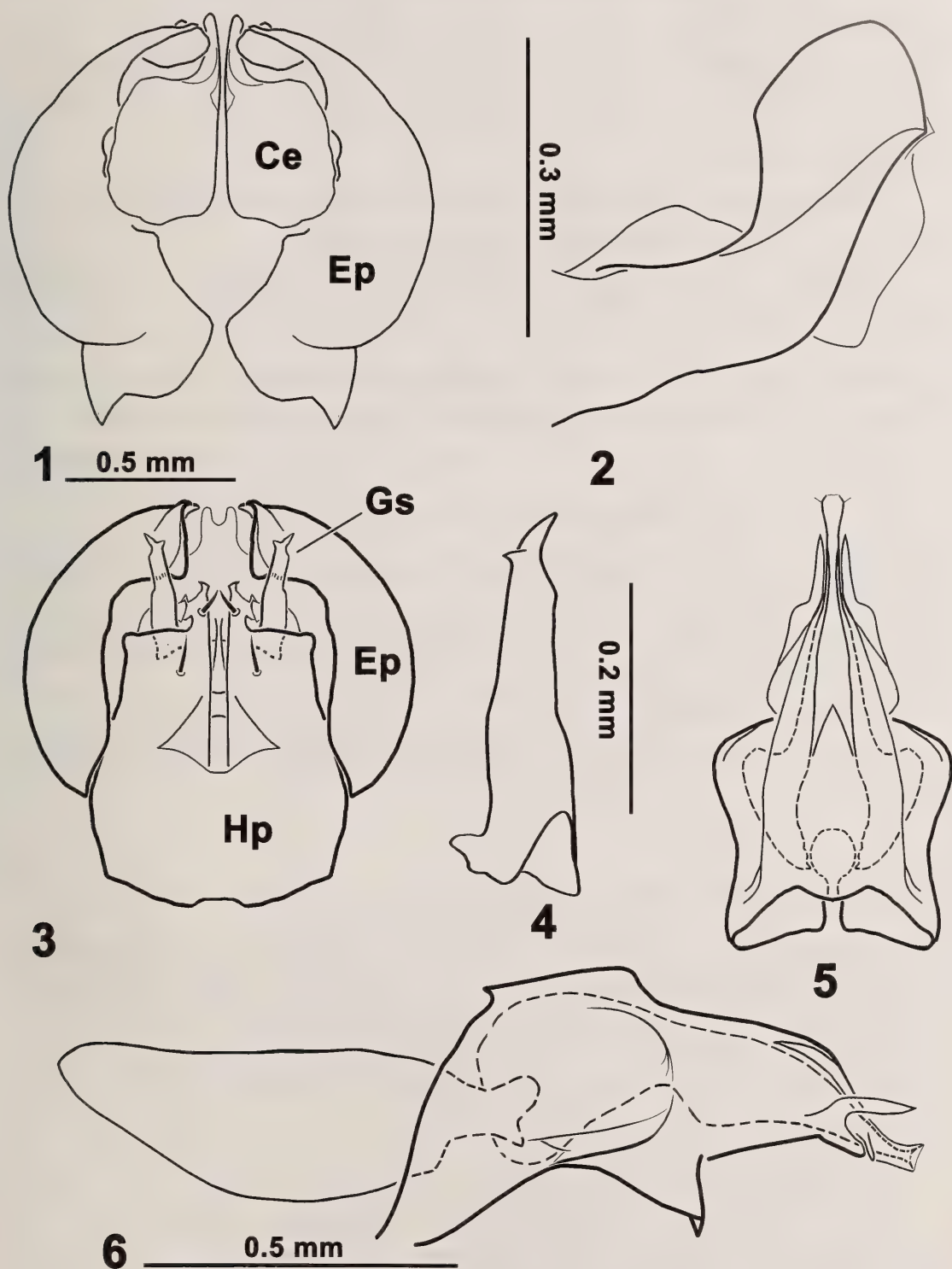
Head. Face and frons yellowish-gray tomentose, vestiture yellow, facial setae long, abundant on ventral half, sparse dorsally; face $1/8.3$ as wide as head. Palpus entirely and ocellar tubercle mostly black setose. Proboscis and frons entirely, and antenna mostly yellowish setose, pedicel black setose dorsally. Antenna brown, flagellum twice as long as wide, longer than either scape or pedicel. Ocellar tubercle with longest seta subequal to basal three antennal segments combined. Occiput with five to six black postocular bristles dorsally, longest strongly proclinate, apex about half the distance toward ocellar tubercle.

Thorax. Mesonotum brown tomentose dorsally, two wide, faint paramedial brownish-yellow tomentose stripes present; postpronotal spot, narrow sides, and posterior yellow; dorsal setae short, mostly black, scattered pale yellow setae present anteriorly, laterally, and posteriorly between dorsocentral rows; three dorsocentral and five lateral bristles present, most black, one each yellowish-brown; dorsocentral bristles shorter and thinner than lateral bristles. Scutellum yellow tomentose with scattered yellow setae and four marginal bristles, two blackish, two yellowish-brown; preapical groove present. Pleuron yellow to yellowish-gray tomentose, bristles and setae yellow; anepimeral bristle present. Halter yellow, knob slightly brownish-yellow.

Wing. Strongly dilated beyond middle portion. Costal and r_1 cells brown to brownish; apical two-thirds microtrichose. Cell r_4 triangular, base narrow, sides gradually diverge to apical third, wide and slightly angled posteriorly beyond; base well beyond apex of cell d. Crossvein r-m just before middle of cell d. Cell m_1 wide basally, slightly more than half as wide as cell at basal third, slight constriction present apically. Cell m_3 long, somewhat narrow, CuA_1+M_3 shorter than r-m crossvein, cell apex truncate, just before base of cell m_1 .

Leg. Coxae and trochanters brown; former yellowish-gray tomentose with abundant, long vestiture, none unusually thick. Fore and middle femora mostly yellow, brown to brownish-yellow apically, mostly yellow setose; ventral setae abundant and long, bristles absent; anterior bristles black. Hind femur with apical two-thirds dark brown, basal third yellow; long, thick, digitate process present basoventrally; anteroventral bristles beyond digitate process absent, only long yellow setae present; bristles before digitate process and those in posteroventral row, most or all black. Tibiae mostly yellow, narrow apex of fore and middle tibiae brownish-yellow, apical third of hind tibia dark brown; lateral bristles black except yellow on fore tibia; hind tibia with short, flat, apical bristle. Tarsi mostly black with black bristles; basal tarsomere of fore and middle tarsi mostly yellow.

Abdomen. Dark brown, narrow apical margins yellow; tomentum sparse, dense on segment 1 and base of tergite 2, mostly gray, brownish-gray laterally and ventrally; mostly yellow setose, long on sides of tergites and on all sternites; black setae present on apical 4 tergites medially.



Figures 1-6. Male terminalia of *Merodontina bellicosa* Scarbrough and Constantino, sp. nov. 1. Dorsal view, 2. Apical club of epandrium, 3. Ventral view, 4. Gonostylus, 5-6. Aedeagus, dorsal and lateral views. Abbreviations: Ep=epandrium, Ce=cercus, Gc=gonocoxite, Hp=hypandrium.

Terminalia (Figs 1-6). Epandrium brown, apex bright yellow especially on inner surface and strongly capitate, flat, narrow, projecting dorsally. Gonostylus with bifurcate apex. Gonocoxite with 2 stout black bristles. Hypandrium narrowed, strongly produced apically, apical margin slightly emarginated medially, bare, without vestiture; 2 long, thin, yellow bristles present laterobasally.

Female. Unknown.

Type Data. Holotype M, **VIETNAM:** Ha Tinh Huong, Son 18° 22'N 106° 13' E, 900 m May 5 1998, Malaise AMNH K. Long, AMNH.

Etymology. Latin *bellicosa* for 'warlike or fierce,' and refers to the predaceous habits of this new species.

Distribution. Vietnam.

Remarks. *Merodontina bellicosa* is distinguished from all congeners by the characters in the key and combined characters of the terminalia (Figs 1-6).

Merodontina thaiensis Scarbrough and Hill

Merodontina thaiensis Scarbrough and Hill 2000a: 103. Holotype M, type locality Chiang [=Chiang], Prov. Doi Suthep, UCRC.

New records. THAILAND: 1 M, 1 F, North Thailand Doi Suthep 25.iv.1958 B. Degerbol leg. Pr. (1.7.59), UZMC.

Distribution. Thailand.

Remarks. *Merodontina thaiensis* differs from congeners by the characters in the key.

KEY TO THE *INSULA* SPECIES GROUP OF *MERODONTINA*

1. Mesonotum with a pair of wide yellowish, paramedial tomentose stripes dorsally; coxae with only whitish vestiture; hind femur of male with only 4-5 stout bristles before ventrobasal digitate process; margin of epandrium apically smooth, without small teeth-like process.....2
- Mesonotum entirely brown dorsally, yellowish paramedial stripes absent; coxae with numerous black setae and bristles; hind femur of male with 10-12 stout bristles before digitate process; margin of epandrium apically with only sparse small teeth-like processes, gonostylus with short black bristles posteriorly; Thailand.....*thaiensis* Scarbrough and Hill
2. Epandrial club wide, oval vertically with anterodorsal notch; gonocoxa dorsally with narrow, rectangular process; gonostylus contrastingly wide medially, narrow apically; Iriomote, Japan*insula* Scarbrough and Hill
- Epandrial club narrow vertically, without anterodorsal notch (Fig. 2); gonocoxa simple dorsally, rectangular process absent; gonostylus gradually narrowed from base to apex, not contrastingly wide medially.....3

3. Epandrial club 'T-shaped' with dorsal and ventral extensions; Iriomote, Japan
*silvatica* Haupt and Azuma
 - Epandrial club 'L-shaped,' ventral extension absent; terminalia as in Figs 1-
 6; Vietnam.....*bellicosa*, **sp. nov.**

SPECIES LIST AND GEOGRAPHICAL DISTRIBUTION OF *MERODONTINA* ENDERLEIN

- bellicosa* Scarbrough and Constantino, sp. nov. Vietnam.
carmichaeli (Bromley) 1935: 225. India.
indiana Joseph and Parui 1984: 32. India.
insula Scarbrough and Hill 2000a: 99. Iriomote Island, Japan.
jianfanglingensis Hua 1987: 186. China.
nigripes Shi 1991: 210. China.
obliquata Shi 1991: 211. China.
robusta Ramachandra Rao and Parui 1969: 110. India.
rufirostra Shi 1991: 213. China.
sikkimensis Enderlein 1914: 262. India.
silvatica Haupt and Azuma 1998: 36. Iriomote Island, Japan.
spinulosa Joseph and Parui 1997: 9. India.
thaiensis Scarbrough and Hill 2000a: 103. Thailand.

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We thank our colleagues and institutions listed in the methods section for the loan of specimens. AGS especially thanks David Grimaldi for help in arranging accommodations and assistance during his visit to AMNH. JC acknowledges support from NSF-REU grant BBI 0097478 at Towson University. We express our thanks to Drs. William L. Grogan of Salisbury University and Joel Snodgrass of Towson University for reviewing this paper.

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A REVIEW OF THE SMALL CARPENTER BEES, *CERATINA*, FROM KOREA, WITH THE DESCRIPTION OF A NEW SPECIES (HYMENOPTERA: APIDAE)¹

Seunghwan Lee,² Hyojoong Kim,² and Wonhoon Lee²

ABSTRACT: Four species of the small carpenter bees, the genus *Ceratina* Latreille, are recognized in Korea, including a new species described here. The new species, *Ceratina* (*Ceratinidia*) *jejuensis* sp. n., was collected exclusively from Jeju Island, the southernmost adjunct from the Korean Peninsula. It belongs to the *C. (Ceratinidia) flavipes*-group, and is easily distinguished from the other species of this group, *C. (Ceratinidia) flavipes*, *C. (Ceratinidia) maai*, and *C. (Ceratinidia) takasagona*, by the characteristic color patterns of head, clypeus, thorax and metasoma, and the shape of sternal teeth and apical lobes on sixth metasomal segment. An identification key to the species of the *C. (Ceratinidia) flavipes*-group is presented with color illustrations of male and female adults of *C. (Ceratinidia) jejuensis* sp. n.

KEY WORDS: *Ceratina*, small carpenter bee, *Ceratina (Ceratinidia) jejuensis*, Korea

The small carpenter bees, *Ceratina* Latreille, constitute a generally solitary group, but occasionally are semisocial or delayed eusocial (Maeta et al., 1993), belonging to the tribe Ceratinini in the subfamily Xylocopinae. *Ceratina* is one of the common pollinators of various wild plants in Far Eastern Asia, and adult females of many species use holes in the narrow stems or twigs of dead plants (*Miscanthus*, *Artemisia*, *Phragmatis* spp. etc.) as nests for brood rearing. Adults are generally shiny black, superficially nearly hairless with many yellow markings on the face, and frequently also on the thorax, legs and metasomal tergites. They are medium-sized to small, ranging from 3.0 mm to 12.5 mm in body length. The genus *Ceratina* consists of 19 subgenera, none of which occurs naturally in both the Eastern and Western hemispheres. There are 13 subgenera in the Eastern Hemisphere, of which only three species [subgenera *Ceratina sensu stricto* (*C. satoi* Yasumatsu, 1936) and *Ceratinidia* (*C. flavipes* Smith, 1879 and *C. japonica* Cockerell, 1911)] have been reported in Korea (Anonymous, 1994).

The subgenus *Ceratinidia* is an oriental subgenus found from Sri Lanka and India throughout southeastern Asia, north to China, Korea and the maritime province of Far Eastern Russia, including Japanese Islands, Taiwan, the Philippines, and Indonesia east to the western end of New Guinea (Michener, 2000). There are about twenty-six species known in these regions (Vecht, 1952; Yasumatsu and Hirashima, 1969; Shiokawa and Hirashima, 1982). The *flavipes*-group of the subgenus *Ceratinidia* Latreille, which was proposed by Yasumatsu and Hirashima (1969), is composed of three species from the Far Eastern Asia, including Korea, China, and Taiwan. Among them, *C. flavipes* is rather widely

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distributed in Korea, Northern China, and Japan. The other two species, *C. takasagona* Shiokawa and Hirashima, 1982 and *C. maai* Shiokawa and Hirashima, 1982, are reported to have limited distributions in Taiwan (Meishan) and Southern China (Chaowu, Tachuland, Fukien and Chungan, Tsiliohiao), respectively.

The subgenus *Ceratina* Latreille *sensu stricto* is rather widely distributed in the Palaearctic regions including Europe, Central Asia to Eastern Asia (Japan, Taiwan, and Thailand), and Africa. It consists of mostly black nonmetallic species with pale coloration limited to the head, pronotal lobes, and legs. There are about 20 known species worldwide, mostly small, and ranging from 5 mm to 9 mm in length.

From recent collections of bees from South Korea, we recognized four species of the genus *Ceratina* from Korea, including a new species of the *flavipes*-group from the southern subtropical island, Jeju-do.

METHODS

For this study, specimens of *Ceratina* were collected directly on various wild flowers using insect nets. Many specimens were also collected using yellow pan traps (YPT), 18 cm diameter plastic dishes, filled with about one-fourth liter of clean water and two drops of dishwasher detergent.

Most specimens studied as well as the holotype designated used in this study are deposited in the College of Agriculture and Life Sciences, Seoul National University (CALS SNU, Korea). Some paratypes and other specimens are deposited in the National Institute of Agricultural Sciences and Technology (NIAST), Suwon, Korea.

For the collection data, abbreviations for the provincial names of South Korea are used, as follows: GG – Gyeonggido, GW – Gwangwondo, CB – Chungcheongbukdo, CN – Chungcheongnamdo, GB – Gyeongsangbukdo, GN – Gyeongsangnamdo, JB – Jeollabukdo, JN – Jeollanamdo, JJ – Jeju-do, UR – Ulreungdo. Plant names of host flowers are according to The International Plant Names Index (2004).

Genus *Ceratina* Latreille

Subgenus *Ceratina* Latreille s. str., 1802

Clavicera Latreille, 1802a, Histoire Naturelle des Fourmis xvi: 432. Type species: *Hylaeus albilabris* Fabricius, 1793 = *Apis cucurbitina* Rossi, 1792

Ceratina Latreille, 1802b, Histoire Naturelle Générale et Particulière des Crustacés et des Insectes 3: 380. Type species: *Hylaeus albilabris* Fabricius, 1793 = *Apis cucurbitina* Rossi, 1792.

***Ceratina (Ceratina) satoi* Yasumatsu, 1936**

Ceratina satoi Yasumatsu, 1936, Annot. Zool. Japon., 15(4): 550-553.

Ceratina (Ceratina) satoi: Yasumatsu and Hirashima, 1969, Kontyu 37: 66.

Specimens examined. 2♂, Cheonan (Mt. Heugseong), CN, 11.iv.1998, leg. June Yeol Choi; 1♂, Seonheul, Jocheon, Bujeju, JJ, 17.vii.1997, leg. Seunghwan Lee.

Distribution. Korea (Southern Part of the Korean Peninsula, Jeju Island) and Japan (Hokkaido, Honshu, Kyushu, Shikoku, Hachiho-jima, Ryukyus), and China (Southeastern Part).

Remarks. This species was described in the Nearctic subgenus *Zadontomerus* by Yasumatsu (1936), but was placed to *Ceratina* s. str. by Yasumatsu and Hirashima (1969). It is not common in the Korean Peninsula. Only two males were collected in the Korean peninsula and one male was collected in Jeju Island.

Subgenus *Ceratinidia* Cockerell and Porter, 1899

Ceratina (Ceratinidia) Cockerell and Porter, 1899, Annals and Magazine of Natural History (7)4: 403-421. Type species: *Ceratina hieroglyphica* Smith, 1854, by original designation.

***Ceratina (Ceratinidia) flavipes* Smith, 1879**

Ceratina flavipes Smith, 1879, Description of new species of Hymenoptera in the collection of the British Museum. p 73.

Ceratina (Ceratinidia) flavipes: Shiokawa, 1963, Kontyu, 31: 276.

Specimens examined. 1♀, Chuncheon, GW, 13.vi.1996, leg. Hyun Jung Choe; 1♂1♀, Mt. Taehwa, Gwangju, GG, 22.vii.1998, leg. Seunghwan Lee; 1♀, ditto, 19.viii.1998, leg. Seunghwan Lee on *Patrinia scabiosaefolia* Link (Valerianaceae); 1♂2♀, Suwon, GG, 20-21.vi.1980, leg. Jong Cheol Paik; 1♀, ditto, 24.vi.1994, leg. June Yeol Choi; 1♀, Suwon, GG, 11.ix.1995, leg. Seunghwan Lee, on *Lycium chinense* Mill (Solanaceae); 1♀, Mt. Gwanggyo, Suwon, GG, 28.viii.1995, leg. Seunghwan Lee; 2♀, Suwon, GG, 27.vii.1995, leg. Hwang Yong Kim, on *Rudbeckia laciniata* L. (Asteraceae); 1♀, ditto, 31.iii.1998, leg. Seunghwan Lee; 1♀, Mt. Yeogi, Suwon, GG, 15.vii.1993; 1♂, Suwon, GG, 16.iv.1994, leg. June Yeol Choi; 1♂, ditto, 22.v.1995, leg. June Yeol Choi; 2♀, ditto, 16.ix.1995, leg. Seunghwan Lee, on *Lespedeza bicolor* Turcz. (Leguminosae); 1♂, Mt. Ungil, Yangpyeong, GG, 19.x.1995, leg. Hwang Yong Kim; 1♀, Gongsan-seong, Gongju, CN, 29.v.1994, leg. June Yeol Choi; 4♂, Baenaegol, Eonyang, Ulsan, GN, 27.v.1998, leg. Seung Hwan Lee, on *Artemisia princeps* Pamp. (Compositae); 1♀, Dogo-ri, Ssangchi-myeon, Sunchang, JB, 12.viii.1998, leg. Seunghwan Lee, on *Lespedeza bicolor*; 1♀, Mt. Baegun, Chusan, Gwangyang, JN, 30.vii.1998, leg. June Yeol Choi.

Distribution. Korea, Northern China, Japan.

Remarks. This species is common in the main Korean peninsula, Japan, and Northern China but has not been collected in Jeju Island.

Ceratina (Ceratinidia) jejuensis S. Lee sp. n.

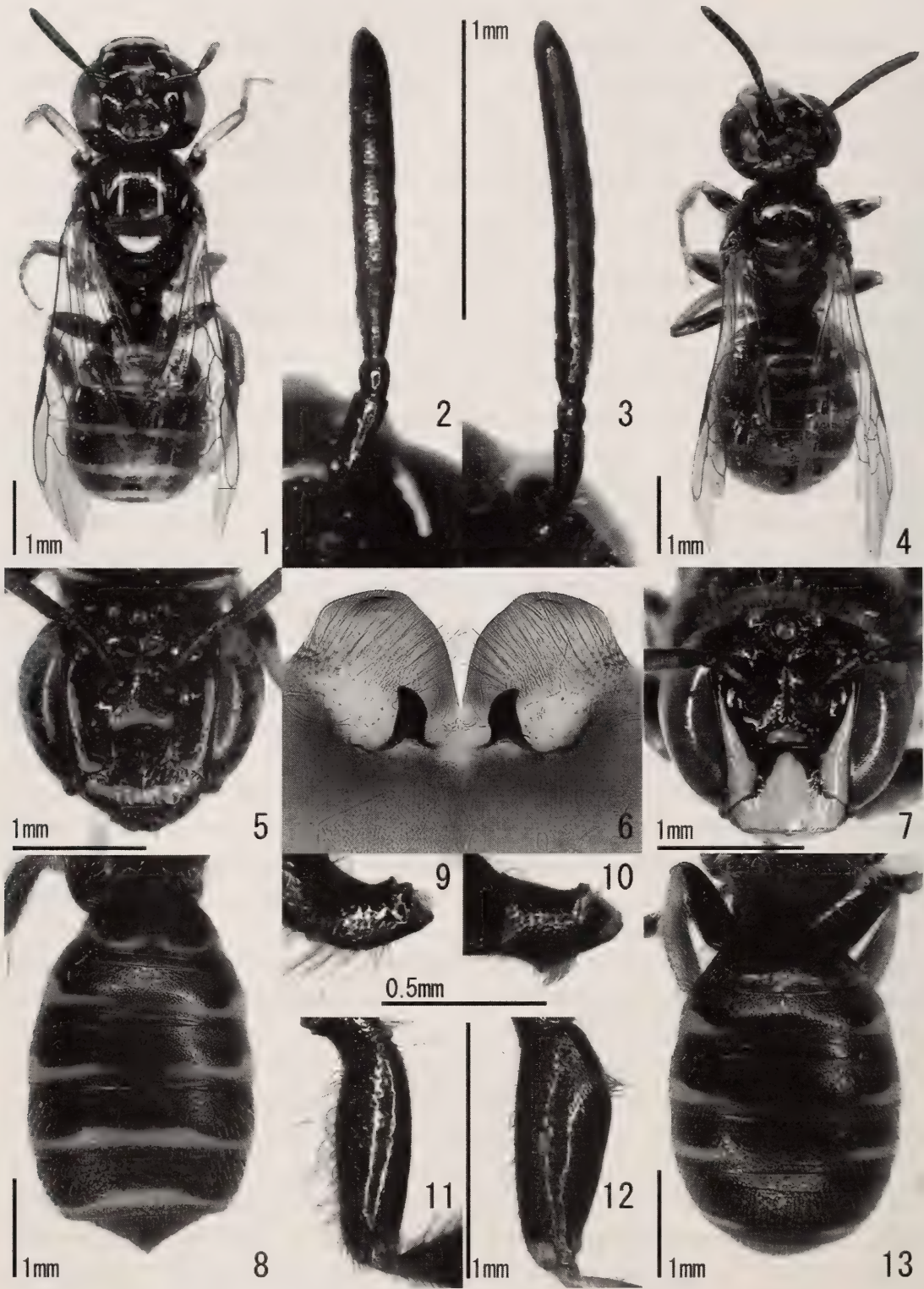
Male. *Color.* Body shiny black, except yellow markings as below (Figs. 1-13). **Head** black shiny with triangular yellow mark on clypeus; frons with well-developed broad yellow mark laterally on paraocular area, attaining antennal socket; yellow mark below well-developed frontal line near clypeus; labrum pale yellow with pair of dark markings laterally and median additional one to clypeal articulation; mandible reddish brown on distal 1/3, yellow in middle, and shiny black basally (Fig. 7). Antennae dark reddish brown with pale yellow small markings at base and distal end of scape (Fig. 3). **Thorax** shiny black except small yellow spot on pronotal lobe; legs with yellow marks on tibiae and tarsi including pretarsi, frequently extending onto ventral parts of front femur and anterior end of femur distally (Fig. 4). **Metasoma** black shiny or blackish brown with narrow yellow bands on lateral parts of posterior margins of terga 1-4 (Fig. 13).

Morphology. Body 5.0 – 6.2 mm long. **Head:** Clypeus rather smooth with a weakly developed median longitudinal carina, with many small punctures laterally; frons smooth with 15-20 punctures along compound eye anterior to antennal socket; frontal line sharply carinate between antennae; antennal grooves smooth with 10-15 punctures along frontal line; vertex between ocelli and compound eye smooth, 20-30 punctures on frons anterior to ocelli, densely covered with long hairs and strong punctures on vertex posterior to ocelli (Fig. 7). Preoccipital carina well distinguished dorsally indistinct laterally. Antennal scape and pedicel weakly punctuated with rather long hairs, longest ones as long as median width of scape; flagellum armed with dense warts and short hairs anteriorly; last segment of flagellum 1.2 times as long as penultimate segment (Fig. 3). **Thorax:** mesoscutum smooth medially with rarely 2-3 irregular rows of punctures to parapsidal line, densely punctuated on anterior 1/3, posterior 1/4, and marginally; scutellum and metanotum densely punctured; meso- and metapleuron densely punctuated with a small smooth area below wing attachment. Hind coxa enlarged triangularly, densely punctuated with smooth lateral area; antennal cleaner well-developed by front tarsus and spur on front tibiae; outer spine well-developed on distal end of fore- and hind-tibiae; longest tibial spur more than 1/2 length of first hind tarsal segment; posterior projection of hind trochanter well-developed with a tuft of long, golden, decumbent ventral hairs on hind trochanter and hind femur (Figs. 10, 12); tarsi and tibiae covered with long hairs. Propodeum densely wrinkled basally and punctuate distally, mediolongitudinal ridge weak, but conspicuous. **Metasoma:** metasomal terga with dense punctures; terga 4-6 with combination of large and small punctures; median apex of tergum 7 distinctly produced, lateroapical portions with an area of smooth surface. Sixth metasomal sternum (Fig. 6) with a pair of well-developed apical lobes, with many pale yellow hairs except on apical margin and bases of median teeth; subapical depression armed with a pair of strong teeth, arising at basal ridge of depression; teeth bent outward at apices, as long as distance between two teeth.

Female. *Color.* Body shiny black with conspicuous yellow markings as follows. Head shiny black with well-developed transverse yellow mark on anterior margin of clypeus (Fig. 5); longitudinal yellow stripe of paraocular area along compound eye bent inward anteriorly, frequently interrupted in middle; a median horizontal yellow stripe on upper border of clypeus below antennal sockets; a pair of eyebrow shape spots between antennae and ocelli. Thorax shiny black with yellow spots on lateral margin of pronotum and pronotal lobe, two pairs of long mesial and short marginal lines on scutum, one triangular large spot on scutellum (Fig. 1). Legs reddish brown to dark brown except tibiae and tarsi paler than femur, with a yellow spot at bases of tibiae. Metasomal terga 1-5 with transverse posterior yellow bands; band interrupted on tergum 1 in middle, each side with bowl shape depression; terga II-III with bands narrow and interrupted in middle, broad laterally; terga IV-V with complete bands, broader in middle and each margin (Fig. 8). Genitalia similar to *C. flavipes* and *C. maai*: gonocoxite strongly constricted before gonostylus; distal apex of gonostylus obtuse with many long hairs (ca. 20); penis valve very long and tapering, sickle-shaped, consisting basal stem and distal blade, distal blade more than 3 times as long as basal stem; spatha broadly rounded apically and abruptly narrowed and stemmed posteriorly, forming mushroom shape.

Morphology. Body 5.7 – 8.5 mm in length. **Head:** Clypeus conspicuously punctured, ridged medio-longitudinally, frons with 10-15 punctures on paraocular area between clypeus and compound eyes, anterior to antennal attachment, along median ridge between antennae. Scutum smooth medially with 1-2 irregular rows of punctures along medial line, finely and strongly punctured on anterior 2/5, posterior 1/5, and marginally. Scutellum sparsely punctured in middle. Hind trochanter without posterior projection; hind trochanter and femur without the tuft of long golden decumbent ventral hairs (Figs. 9, 11)

Type Materials. Holotype: male, Seonheul, Jocheon, Bugjeju, JJ, South Korea, 17.vii.1997, leg. Seunghwan Lee (YPT). Paratypes: 34♀28♂, from the same collection of holotype; 8♀2♂, same location of holotype, 17.iv.1998, Seunghwan Lee; 3♀, ditto, 17.iv.1998, leg. Seunghwan Lee (YPT); 3♀, ditto, 17.vii.1998, leg. Seunghwan Lee; 1♂, Citrus Experimental Station, Namwon, Namjeju, JJ, 23.xi.1996, leg. June Yeol Choi, by Malaise Trap; 1♀, Namwon, Namjeju, JJ, 25.viii.1994, leg. Deok Seo Ku; 5♂2♀, Jedong, Namwon, Namjeju, JJ, 17.iv.1996, Leg. Seunghwan Lee; 2♀, Jeju Country Club, Jeju, JJ, 10.vi.1998 (YPT); 1♀, Eorimog, Bugjeju, JJ, 10.viii.1995, leg. Seunghwan Lee; 1♀, Goraengjipojang, Bugjeju, JJ, 15.iv.1998, leg. Seunghwan Lee; 3♀, Gwaneumsa, Jeju, JJ, 26.v.1985; 3♂16♀, ditto, 17.vii.1997, leg. Seunghwan Lee (YPT); 3♀8♂, ditto, 17.iv.1998, leg. Seunghwan Lee (YPT); 2♀, 1100m Rest Area, Mt. Halla-san, Seogwipo, JJ, 11.vi.1998, leg. Seunghwan Lee; 1♀, Natural Forest Resort, Mt. Halla-san, Seogwipo, JJ, 17.iv.1998, Seunghwan Lee.



Figures 1-13. *Ceratina (Ceratinidia) jejuensis* S. Lee sp. n.: 1, Female adult; 2, Antenna of female; 3, Male antenna; 4, Male adult; 5, Frontal view of female head; 6, Sixth abdominal sternum of male; 7, Frontal view of male head; 8, Dorsal view of female abdomen; 9, Hind trochanter of female; 10, Hind trochanter of male; 11, Hind femur of female; 12, Hind femur of male; 13, Dorsal view of male abdomen.

Distribution. Korea (Only in Jeju Island)

Etymology. The species name '*jejuensis*' is derived from the name of type location 'Jeju-do' where all type series were collected.

Diagnosis. Color pattern and genitalia of male *C. (Ceratinidia) jejuensis* sp. n. similar to that of *C. (Ceratinidia) flavipes* and *C. (Ceratinidia) maai*, from which this new species can be distinguished by the frons which has broad black gaps between the yellow clypeus and paraocular areas, thus forming the triangular yellow pigmentation on clypeus (Frons entirely covered by yellow pigmentation in *C. (Ceratinidia) flavipes* and with narrow black gaps on the epistomal suture in *C. (Ceratinidia) maai*, making an upside-down hat shape). In addition, the new species is distinguished from *C. (Ceratinidia) flavipes* by the angulated produced apical lobes on 6th sternum (apical lobes smooth without angulated points in *C. (Ceratinidia) flavipes* and is also distinguished from *C. (Ceratinidia) maai* by the apical lobes with hairs confined to the middle (hairs distributed on the whole apical lobes in the latter species). The color pattern of female adults of the new species is similar to the Taiwanese species, *C. (Ceratinidia) takasagona*, from which it can be differentiated by the shape of yellow pigmentation on the first metasomal tergum and the clypeus.

Ceratina (Ceratinidia) japonica Cockerell, 1911

Ceratina hieroglyphica var. *japonica* Cockerell, 1911. Proceedings of the United States National Museum, 39: 635.

Ceratina (Ceratinidia) japonica: Shiokawa, 1963, Kontyu, 31: 278.

Specimens examined. Numerous males and females were collected throughout South Korea, excluding Jeju Island, using yellow pan traps (YPT), sweep nets, and by hand directly on flowers. They are found continuously from April to October, and are common in spring, April-May, and early autumn, August-September.

Host flowers observed. *Carduus crispus* L. (Asteraceae), *Chaenomeles lagenaria* Koiduzumi (Rosaceae), *Chrysanthemum indicum* L. (Compositae), *Erigeron Canadensis* L. (Asteraceae), *Lespedeza bicolor* Turcz. (Leguminosae), *Malus pumila* Mill. (Rosaceae), *Patrinia scabiosaefolia* Link (Valerianaceae), *Pueraria thunbergiana* Benth (Leguminosae), *Rhododendron mucronulatum* Turcz. (Ericaceae), *Rhododendron schlippenbachii* Maxim (Ericaceae), *Rosa multiflora* Benth. (Rosaceae), *Saussurea pulchella* Fisch. ex Colla. (Compositae), *Vicia amurensis* Oettingen (Leguminosae), *Youngia sonchifolia* Maxim. (Compositae).

Distribution. Korea (mainland of the Korean Peninsula, excluding Jeju Island), Japan, China.

Remarks. This is the most common species of the genus *Ceratina* in Far Eastern Asia. However, it has not been recorded in Jeju Island.

Key to the species of the *Ceratina* (*Ceratinidia*) *flavipes*-group

Males

1. Clypeus, paraocular area, and supraocular area wholly yellow without dark gaps between clypeus and paraocular area. All transverse yellow band of metasomal terga broadly interrupted medially. (Widely distributed in Far Eastern countries: Korean Peninsula, Japan, China)
.....*Ceratina* (*Ceratinidia*) *flavipes*
- Frontal pigmentation on clypeus, paraocular area, and supraocular area separated by black areas along the sutures. Transversal yellow bands, at least of terga 4-5, not broken or with narrow gaps only in middle 2
2. Preoccipital carina low but distinct. Seventh tergum with apical margin only slightly produced apically in middle, latero-apical portions coarsely sculptured as in rest of same tergum. Hind femur rather thick with anterior face distinctly convex; subapical tuft of decumbent golden hairs not arranged in a compact fringe. Sixth sternum with a pair of small denticles very close together. Body length less than 5.5 mm. (Taiwan: Meisan, Nantow).
.....*Ceratina* (*Ceratinidia*) *takasagona*
- Preoccipital carina weak or absent. Seventh tergum with apical margin distinctly produced apically in middle, latero-apical portions broadly smooth and shining. Hind femur not thick; subbasal tuft of golden decumbent hairs long and arranged in a compact fringe. Sixth sternum with a pair of robust and broadly separated denticles. Larger species 3
3. Yellow pigmentation covering on almost whole clypeus except narrow gaps on epistomal suture, forming hat-shaped yellow marking on clypeus. Transverse yellow bands on anterior three metasomal terga narrowly interrupted and distal two band with narrow gaps. Hairs on apical lobes of sixth metasomal sternum distributed over entire lobes. (China: Fukien)
.....*Ceratina* (*Ceratinidia*) *maai*
- Yellow marking on clypeus triangular, broadly interrupted along epistomal suture (Fig. 7). Transverse yellow bands on terga broadly interrupted (Fig. 13). Hairs on apical lobes of sixth abdominal sternum confined in the middle of lobes, base and apices of lobes bare (Fig. 6). (Korea: Jeju Island)
.....*Ceratina* (*Ceratinidia*) *jejuensis* S. Lee sp. n.

Females

1. Thorax with two pairs (medial and lateral) of well developed longitudinal yellow streaks on scutum; transverse yellow bands on metasoma complete, not interrupted medially 2
- Thorax with one pair of longitudinal yellow streaks on scutum; transversal yellow bands interrupted at least on first and second terga 3
2. Preoccipital carina low, but distinct; clypeus not coarsely sculptured, rather smooth, shiny, with a median longitudinal ridge; yellow mark on clypeus large, inverted T-shaped. Transversal yellow marking on first metasomal tergum broad with two small black spots laterally. Body length 5 – 7 mm. (Taiwan: Meisan, Nantow)*Ceratina (Ceratinidia) takasagona*
- Preoccipital carina absent; clypeus sculptured without or with very indistinct indication of longitudinal ridge; yellow mark transverse, without longitudinal bar. Transversal yellow marking on first metasomal dorsum not as above, almost W-shaped with a small longitudinal bar in middle. Relatively large species, 5.7-8.4 mm in body length. (Korea: Jeju Island)*Ceratina (Ceratinidia) jejuensis* S. Lee sp. n.
3. Preoccipital carina weak but often well recognizable; basal area of propodeum usually without a median ridge; metasomal yellow bands, especially those on three basal terga, not well developed; clypeus without median ridge. (Widely distributed in Far Eastern countries: Korean Peninsula, Japan, China)*C. (Ceratinidia) flavipes*
- Preoccipital carina absent; basal area of propodeum with a median longitudinal ridge (although weak); metasomal yellow bands well developed; clypeus with an indication of median ridge. (China: Fukien)*C. (Ceratinidia) maai*

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CONTRIBUTION TO THE TAXONOMY OF *ASIOPLEX* (EPHEMEROPTERA: LEPTOHYPHIDAE: TRICORYTHODINAE) IN THE NEW WORLD¹

N. A. Wiersema² and W. P. McCafferty³

ABSTRACT: North, Central, and South American species of the genus *Asioplax* (Leptohyphidae: Tricorythodinae) are comparatively reviewed and diagnosed. The male adult of *A. dolani* and male and female adults of *A. edmundsi* are described for the first time. Adults of *A. texana* are comparatively redescribed. Two South American species previously considered in *Tricorythodes* are newly transferred to *Asioplax*: *A. santarita*, n. comb. and *A. zunigae*, n. comb. *Asioplax corpulenta* is shown to be a junior subjective synonym of *A. edmundsi*, n. syn. Stage correlated identification keys to species, incorporating range characteristics, are provided.

KEY WORDS: *Asioplax*, Ephemeroptera, Leptohyphidae, Tricorythodinae, New World

In the early mid-1990s we became aware initially of two species of Leptohyphidae with highly unusual larvae that could not be clearly placed to any of the genera that had historically constituted that Western Hemisphere family. One of these species was described from Costa Rica by Lugo-Ortiz and McCafferty (1995a) as *Leptohyphes curiosus* Lugo-Ortiz and McCafferty. Those authors stated that their species was unique because of its small size, flattened body, posterolateral projections on abdominal segments 7 and 8, leg setation, and shape of the operculate gills. Lugo-Ortiz and McCafferty (1995a), while describing this species in the genus *Leptohyphes* Eaton, pointed out that it possessed some characteristics that were historically associated with *Tricorythodes* Ulmer. A generically similar second species had been collected in Texas and was even more dramatic with respect to its characterization of being small, squat and depressed. Our suspicions that these species represented a distinct new genus were borne out by subsequent revisionary work on the Leptohyphidae (Wiersema and McCafferty 2000). The review of species incorporated in the latter study resulted in a small number of additional congeners (previously in either *Leptohyphes* or *Tricorythodes*) all being placed in the new genus *Asioplax* Wiersema and McCafferty in the subfamily Tricorythodinae (Wiersema and McCafferty 2000).

The nine species originally placed in *Asioplax* included the unnamed species from Texas referred to above, which has since been described as *A. numinuh* Wiersema, McCafferty and Baumgardner (Wiersema et al. 2001). Five of the species were North American, but the genus also included the Central American species *A. curiosa*, mentioned above, and *A. nicholsae* (Wang, Sites, and McCafferty) from South America, a species that had been noted by its authors (Wang et al. 1998) as being similar in generic characterization to *A. curiosa*. In addition, two species known only from Cuba, *A. sacculobranhis* (Kluge and Naranjo) and

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A. sierramaestrae (Kluge and Naranjo) were included in the genus on the basis of somewhat incomplete descriptions (Kluge and Naranjo 1990). Because these latter two species have not been available for further study, they are not treated herein and their placement in *Asioplax* is considered provisional. Recently, Molineri (2002) provided a taxonomic treatment of South American *Tricorythodes* species including two species that are congeneric with *Asioplax*: *A. santarita* (Traver), n. comb., and *A. zunigae* (Molineri), n. comb. The phylogenetics presented by Molineri (2002) support the recognition of this grouping as a distinct genus, although that author chose to retain a broadly encompassing, less informative taxonomic concept of *Tricorythodes* consisting of multiple clades.

The purpose of this paper is to present synonymies of current North, Central, and South American species; the first descriptions or comparative redescriptions of the adult stage of certain of the species that have not been well understood in that regard; and comparative diagnoses of species accompanied by identification keys.

Asioplax

Asioplax Wiersema and McCafferty, 2000:347.

Type species: *Tricorythodes edmundsi* Allen.

Diagnosis. Larva: These are relatively small, broad forms only rarely greater than 4.0mm in length, often 2.6 to 3.3mm and only rarely as much as 5.5mm. Larvae of *Asioplax* have in common with most other Tricorythodinae genera a combination of having abdominal terga 1-6 lacking spines at their posterior margins, hindtarsi that are more than one-half the length of the hindtibiae, and a thorax devoid of hingwingpads in both sexes. *Asioplax* larvae may be distinguished from those of other Tricorythodinae genera and leptohyphids in general by a combination of the relatively small, depressed and broad appearing, setate body and legs; well-developed posterolateral projections of abdominal segments 8 and 9 that are generally longer than the midlength of their respective terga; broadened forefemora that are as wide or nearly as wide as long, that have their transverse dorsal setal row located near the base of the femur, and that have well-developed marginal setae; and either an absence of the inner ventral lamellae of operculate gills or the presence of one that is less than one-half the length of the outer lamellae. See also key characters discussed by Wiersema and McCafferty (2000) and further modified by Wiersema and McCafferty (2004).

Adult: As per other Tricorythodinae, *Asioplax* adults lack hindwings in both sexes; have ventrodistally extended hindtibiae on all legs of females and on the mid- and hindtibiae of males; have a mesonotum [Fig. 4 (Wiersema and McCafferty 2000)] that has the paired longitudinal posterior and anterior parapsidal sutures merging anterior to the transverse interscutal suture, that has poorly developed and anteriorly well separated posterior scutal lobes, and that does not have a developed posterior transverse sulcus; and have forewings that are widest at the base in males and widest at midlength in the females. Among Tricorythodinae adults, *Asioplax* is most similar to *Epiphrades* Wiersema and McCafferty and some *Tricorythodes* in that both may be diagnosed as having three-segmented forceps, eyes that are not

sexually dimorphic (i.e. not greatly enlarged in the males), an IMP vein that is not longer than MP_2 , lateral ocelli that are widely separated, and male foretarsi that are greater than one-half the length of the foretibiae. In addition, *Asioplax* adults share with *Epiphrades* and some species presently considered *Tricorythodes*, a male subgenital plate that is not extended beyond the forceps bases and in females reduced cerci, lacking fine setae and elongated medial caudal filament with extensive setation. *Asioplax* adults, however, can be differentiated from those of all other species presently considered *Tricorythodes* and *Epiphrades* by a combination of relatively small body size (2.4-4.0mm) and hindfemora that are about three-fourths or more of the length of the hindtibiae and hindtarsi combined.

Asioplax curiosus

Leptohyphes curiosus Lugo-Ortiz and McCafferty, 1995a:170.

Asioplax curiosus (Lugo-Ortiz and McCafferty): Wiersema and McCafferty, 2000:348.

Diagnosis. Larva: The only known body length is 2.8mm. The maxillae are devoid of palps. The setae of dorsal transverse row on the forefemora are hairlike. Anterior lateral setae of the mid- and hindfemora are longer than the posterior lateral setae. Tarsi do not have a dark blue pigmentation basally. Claws have five to six denticles and a subapical seta. Tubercles are not found on the abdominal terga. Posterolateral projections of abdominal segment 9 are very poorly developed [Fig. 10 (Lugo-Ortiz and McCafferty 1995a)]. Operculate gills are somewhat ovate and somewhat pointed.

Adult: Unknown.

Material Examined. Holotype female larva, Costa Rica, Guanacaste Prov., Río Tenerio at Ficina La Pacifica, E of Panamerican Hwy., II-2-1969, WP McCafferty, Purdue Entomological Research Collection (PERC).

Distribution. Central America: Costa Rica and Panama.

Asioplax dolani

Leptohyphes dolani Allen, 1967:351.

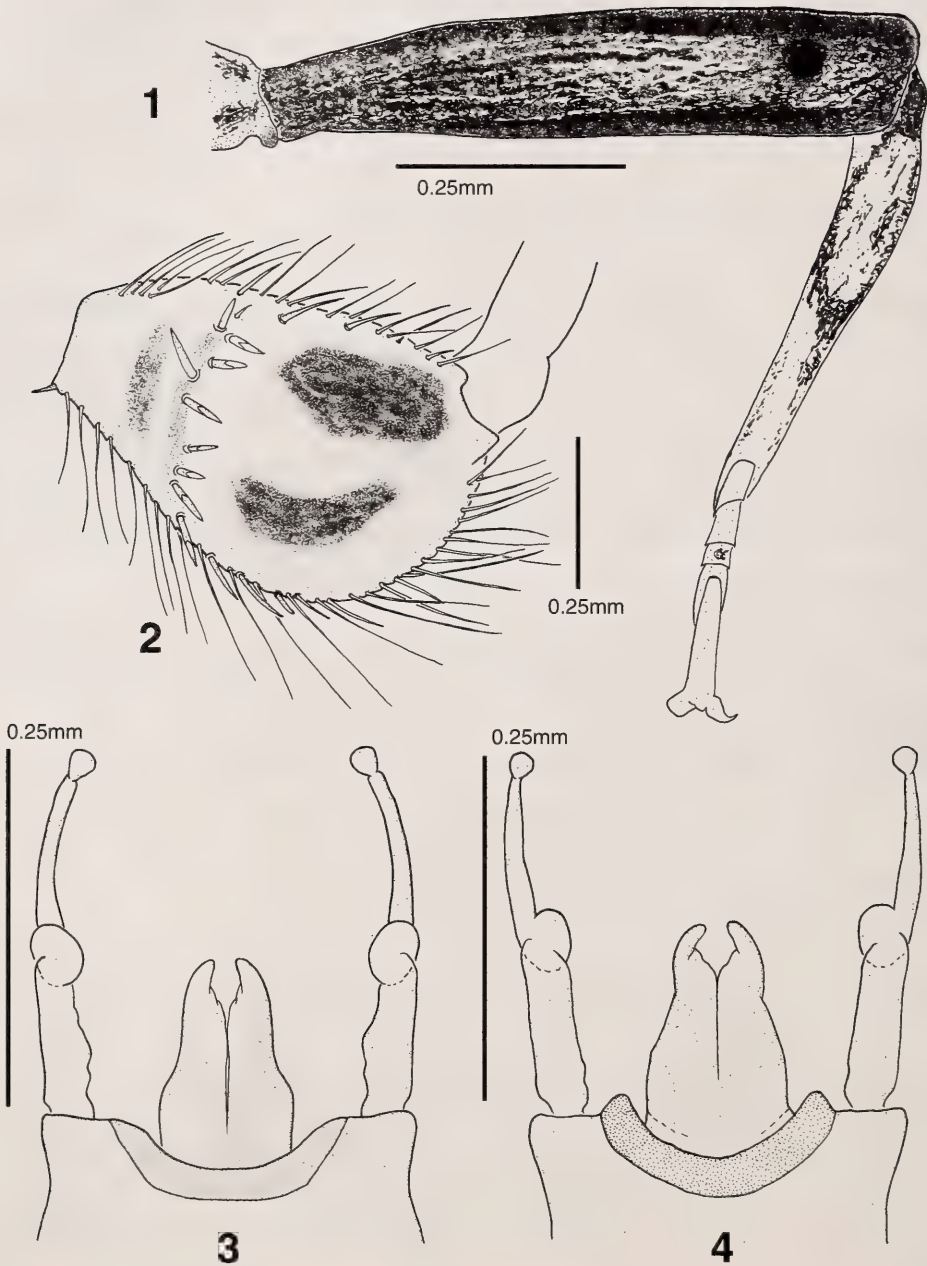
Asioplax dolani (Allen): Wiersema and McCafferty, 2000:348.

Male adult. Body: Length 2.6mm. General coloration red-brown with extensive black markings. Head: Coloration almost entirely black with medial triangulate pale area between lateral ocelli with epicranial sutures not darkly pigmented, and ocelli encircled with black basally. Eyes widely separated, with diameter greater than basal width of lateral ocelli. Thorax: Not a deep red-brown with extensive black markings. Forewings length 3.5mm. Forelegs approximately one and one-half times length of body. Femora, tibiae and tarsi of mid- and hindlegs extensively covered with black markings (Fig. 1). Mid- and hindtibiae with black shading and speckling basally extending down to a U-shaped mark at half the tibial length. Hindfemora subequal in length to hindtibiae and hindtarsi combined. Abdomen: Terga with sublateral, submedial and medial dark maculae, appearing as alternating dark and light longitudinal stripes. Sterna with lateral muscle insertion marks blue-black. Genitalia unknown. Caudal filaments gray-white.

Female adult. Unknown.

Diagnosis. Larva: The mature body length may be as much as 4.5mm. Maxillary palps are present and two-segmented. The setae making up the dorsal transverse row are spatulate, and these spatulate setae are also interspersed with hairlike setae

along the posterior margin of the forefemora (Fig. 2). Tarsi lack any bluish or blue-black pigmentation basally. Claws have two or more (commonly three) small denticles at the base of the inner curvature. Abdominal terga lack tubercles and have conspicuous paired submedian maculae across the width of each tergum. Posterolateral projections of abdominal segment 9 are well developed, narrowly pointed, and have straight margins. Operculate gills are subovate and could be interpreted as only broadly pointed at most.



Figures 1-4. *Asioplax*. 1. *A. dolani*, male adult hindleg. 2. *A. dolani*, larval forefemora. 3. *A. edmundsi*, male adult genitalia, ventral view. 4. *A. texana*, male adult genitalia, ventral view.

Adult: The male may be distinguished from male adults of other known species

by the head color pattern consisting of black pigmentation except for a conspicuously pale wedge-shaped area between the lateral ocelli.

Material Examined. Larvae, North Carolina, Johnston Co, Neuse R, nr Princeton, VII-1991, and Sampson Co, Black R, nr Tomahawk, VII-1988, DR Lenat, PERC. Reared male adult, exuviae, and 6 larvae, South Carolina, Barnwell Co, Steel Creek at Cypress Bridge, IX-15-1984, BC Kondratieff, collection of NA Wiersema (NAW).

Distribution. North America: USA: Alabama, Florida, Georgia, North Carolina, South Carolina, and east Texas.

Remarks. The above represents the first adult description of *A. dolani*. The female adult remains unknown, and because there are no genitalia from the single reared adult specimen available for study, further documentation of this life stage will be necessary.

This is the only species of *Asioplax* known from the Southeast or eastern North America in general. Allen (1978) reported this species from Victoria County, Texas. We have been unable to locate the larvae on which the record was based. Although, this species was recently confirmed from east Texas by Baumgardner et al. (2003), we believe the records from Victoria County could be representative *A. dolani*, *A. numinuh*, or even the unknown larva of *A. texana* (Traver).

Asioplax edmundsi

Tricorythodes edmundsi Allen, 1967:370.

Tricorythodes corpulentus Kilgore and Allen, 1973:330, n. syn.

Asioplax edmundsi (Allen): Wiersema and McCafferty, 2000:348.

Asioplax corpulenta (Kilgore and Allen): Wiersema and McCafferty, 2000:348, n. syn.

Male adult. Body: Length 2.8-3.1mm. Coloration pale brown with black markings. Head: Coloration yellow-brown with epicranial sutures darkly pigmented, sometimes with blackish speckling, and with ocelli encircled with red-brown basally. Eyes widely separated, with diameter slightly more than basal width of lateral ocelli. Thorax: Not a deep yellow-brown with sparse red-brown to black-blue markings. Forewings length 3.2-4.0mm. Forelegs approximately one and one-half times length of body. Mid- and hindfemora with sparse red-brown to black-blue markings. Mid- and hindtarsi shaded basally with blue-black. Hindfemora subequal in length to hindtibiae and hindtarsi combined. Abdomen: Terga with sublateral, submedial and medial dark maculae, appearing as alternating dark and light longitudinal stripes. Sterna with lateral muscle insertion marks not pigmented. Subgenital plate shallowly emarginated (Fig. 3). Basal swelling of second forcep segment basomedially directed. Caudal filaments gray-white.

Female adult. Body: Length 2.7mm. Coloration generally black-brown with few light markings (legs light except marked with black-brown at joints, and caudal filaments light). Head brown, except for narrow pale epicranial suture margins and narrow pale transverse band at posterior border of head. Forewings length 4.4mm. Subanal plate well developed into transparent convexity extending beyond bases of caudal filaments.

Diagnosis. Larva: The mature body length may be as much as 5.5mm, according to Kilgore and Allen (1973); however, most mature larvae we have seen are not longer than 4.0mm. Maxillary palps are absent. The setae making up the dorsal transverse row on the forefemora are hairlike [Fig. 1 (Wiersema and McCafferty 2000)]. Tarsi typically have a blue-black pigmentation basally. Claws have a basal row of five to seven denticles and paired denticles (can be very minute) located at the lateral, subdistal edges of the claws. Abdominal terga lack tubercles. The pos-

terolateral projections on abdominal segment 9 are well developed and narrowly pointed but extend only to about the length of sternum 9. Posterolateral projections of segment 8 appear much more posteriorly oriented from their base than those of segment 7, which are posterolaterally oriented from the base. Sternum 9 of female larvae is truncate distally. Operculate gills are broadly subovate (or what could also be interpreted as subtriangulate) and appear nearly round except for a somewhat straight lateral margin.

Adult: Males have a yellow-brown head with dark sutures and sometimes some degree of dark speckling. The subgenital plate is wide and shallowly emarginate. Both sexes have dark blue pigmentation basally on the tarsi, and both lack dark lateral dashes on the abdominal sterna. Females have a primarily solid black-brown body and dark brown head with a pale posterior border. The subanal plate of female reaches distally, considerably beyond the bases of the caudal filaments.

Material Examined. Larval paratypes, Utah, Daggett Co, Green R, IX-11-1952, GF Edmunds, PERC; 2 larvae, Colorado, Moffatt Co, Yampa R, NAW; 2 larvae, Colorado, Moffatt Co, Green R, VII-24-1992, NAW; Larvae, Colorado, Moffatt Co, Green R, VI-28-1956, E Mills, PERC; reared male adults and larval exuviae, Saskatchewan, Torch R, N of Hwy 35, VII-16-2001, JM Webb, in collection of collector; reared female adult and larval exuviae, Saskatchewan, South Saskatchewan R, at Lemsford Ferry, IX-16-2000, JM Webb, in collection of the collector; 10 male adults, Utah, Uintah Co, White River, 1 mi south of Bonanza, VII-24-1988, GF Edmunds, PERC.

Distribution. North America: Canada: Saskatchewan; USA: Colorado, Idaho, New Mexico, and Utah.

Remarks. The above represents the first formal description of the adults of this species, although some adult figures were published by Wiersema and McCafferty (2000).

We have herein placed *A. corpulenta* as a junior subjective synonym of *A. edmundsi*, n. syn., based on the following: The only structural larval characteristic that Kilgore and Allen (1973) could ostensibly use to distinguish their *A. corpulenta* from *A. edmundsi* was the presence of paired subapical denticles in the former. Allen (1967) had not mentioned the presence of such denticles in his description of *A. edmundsi*. Examination of the paratopotypes of *A. edmundsi* under compound high magnification, however, has revealed the presence of these paired subapical denticles. These structures can be difficult to detect and this situation has evidently contributed to other previous identifications as *A. corpulenta*. Color pattern characters of the forefemora and operculate gills that Kilgore and Allen (1973) assigned to either *A. corpulenta* or *A. edmundsi* are not consistent among and within populations. The availability of only one or very few specimens, however, evidently also led to previous identifications of *A. corpulenta*.

A reared female (and only female adult known of *A. edmundsi*) has a dimorphic much longer forewing than that of the male (compare 4.4mm in the female vs. 3.2mm in the male of northern populations, although body lengths are 2.7 and 3.0, respectively). The female body also has a much more solid blackish color rather than the more granular black patterning on the yellow ground color seen in the male. This striking sexual dimorphism with respect to coloration is not seen in *A. numinuh* or *A. texana* (Traver).

Lugo-Ortiz and McCafferty (1995b) reported *A. edmundsi* from central Texas both as *T. edmundsi* and *T. corpulentus*. These reports, however, are referable to *A. numinuh*, and Wiersema et al. (2001) pointed out that larval paratypes of

T. edmundsi from Tamaulipas, Mexico, were actually misidentified *A. numinuh*. Therefore, *A. edmundsi* remains known only from western Canadian and USA drainage systems. Lester et al. (2002) noted that the species appeared limited to low-gradient streams and rivers and was tolerant of high sediment levels and warm summer temperatures.

Asioplax nicholsae

Leptohyphes nicholsae Wang, Sites, and McCafferty, 1998:69.

Asioplax nicholsae (Wang, Sites, and McCafferty): Wiersema and McCafferty, 2000:348.

Diagnosis. Larva: The body length of the single known specimen is 3.0mm. Maxillae are devoid of palps. The setae making up the dorsal transverse row on the forefemora are hairlike. Tarsi lack any blue or blue-black pigmentation basally. Tarsal claws have a row of four to six denticles. Abdominal terga 3-9 have mid-posterior tubercles, and these tubercles are relatively strongly developed on terga 6-9 [Fig. 9 (Wang et al. 1998)]. Posterolateral projections of abdominal segment 9 are small yet distinctive, being only somewhat developed. Operculate gills are subovate and posterolaterally somewhat falcate, making them appear slightly pointed.

Adult: Unknown.

Distribution. South America: Ecuador.

Remarks. *Asioplax nicholsae* larvae have tergal tubercles, a distinctive feature shared only with the South American species *A. santarita*.

Material Examined. Holotype (male larva) and paratype (female larva), Ecuador, Pichincha Prov, Rio Peripa at Puerta Limon, VII-18-1993, PERC.

Asioplax numinuh

Asioplax numinuh Wiersema, McCafferty, and Baumgardner, 2001: 301.

Diagnosis. Larva: The mature body length ranges from 2.6 to 3.8mm. Maxillae are devoid of maxillary palps. The setae making up the dorsal transverse row of the forefemora are hairlike. Tarsi lack any blue-black pigmentation. Claws have a row of five to six basal denticles and lack subapical paired denticles. Abdominal terga lack tubercles [Fig. 1 (Wiersema et al. 2001)]. The posterolateral projections of abdominal segment 9 are well developed, extending well beyond sternum 9. Posterolateral projections of abdominal segments 7, 8, and 9 are essentially posteriorly oriented from their base. Sternum 9 in the female larvae is slightly emarginate distally to nearly truncate [Fig. 2 (Wiersema et al. 2001)]. Operculate gills are relatively elongate with a somewhat rounded medial margin and a somewhat straight lateral margin.

Adult: Males range from 2.8-3.0mm in length, with their wing length ranging from 3.8 to 4.0mm. The dark coloration of the head and a deep and narrowly emarginate of the subgenital plate [Fig. 4 (Wiersema et al. 2001)] are important distinguishing characteristics. Both sexes have hindfemora that are subequal in length to the hindtibiae and hindtarsi combined [Fig. 3 (Wiersema et al. 2001)], and they lack lateral dashes on the abdominal sterna. Females range from 3.6 to 3.8mm in length,

with their wing length ranging from 4.2 to 4.6mm. They are much lighter than females of *A. edmundsi*, and the convex subanal plate is not as distally developed, only reaching the base of the caudal filaments.

Material Examined. Holotype (male larva) and paratypes (male and female larvae and reared male and female adults), Texas, Kerr Co, Guadalupe R, Hwy 27, nr Center Point, IV-14-2000, PERC; 23 larvae, Texas, Val Verde Co, Rio Grande, Del Rio, VIII- 11-1977, JR Davis, NAW; 12 larvae, Texas, Terrell Co, Independence Cr, Chandler Ranch, IV-24-1994, G Larson, NAW; Larvae, Texas, Blanco Co, Blanco R, V-1977, PERC; larvae, Texas, Kerr Co, Robinson Cr, V-1977, PERC; larvae, Texas, Kimble Co, South Llano R, Hwy 456, X-13-1966, R. Waugaman, PERC. See also Material Examined in Wiersema et al. (2001).

Distribution. North America: Mexico: Querétaro and Tamaulipas; USA: central and south Texas.

Remarks. As indicated above, *A. numinuh* has occasionally been reported as *A. edmundsi* in the past. Wiersema et al. (2001) indicated that larvae of this species in Texas were commonly associated with silt-laden periphyton on the tops of flat cobble in stream habitats with rapid but nonturbulent currents.

Asioplax santarita, n. comb.

Tricorythodes santarita Traver, 1959: 130; Molineri, 2002: 293.

Diagnosis. Larva: Body length 3.7mm. Maxillae palps highly reduced and one segmented. The setae making up the dorsal transverse row on the forefemora are hairlike. Tarsi lack any blue or blue-black pigmentation basally. Tarsal claws apparently devoid of marginal denticles, with only paired subapical, submarginal denticles. Large midposterior tubercles present on abdominal terga 7-9. Posterolateral projections of abdominal segment 9 are small yet distinctive, being only somewhat developed. Operculate gills are subovate, lack an interior ventral lamella, and have a highly reduced outer lamella.

Adult: Males range from 3.0-3.1mm in length, with their wing length ranging from 3.0 to 3.5mm. The dark shading of the basal third of the wings and the distinct lateral projections of the subgenital plate are important distinguishing characteristics. Both sexes have hindfemora that are subequal in length to the hindtibiae and hindtarsi combined. Females range from 2.2 (without eggs) to 3.2mm in length, with their wing length ranging from 3.9 to 4.5mm. Vein CuP often merges with vein A, or is reduced, not extending to the hind margin of the wings.

Distribution. South America: Argentina, Brazil and Uruguay.

Remarks. As noted above the larvae of this species should be readily recognizable due to the presence of large tubercles on terga 7-9.

Asioplax texana

Tricorythodes texanus Traver, 1935:638.

Asioplax texana (Traver): Wiersema and McCafferty, 2000:348.

Male adult. Body: Length: 2.8-3.4mm. Coloration pale yellow-brown with black markings. Head: Coloration pale yellow to yellow-brown without dark markings, and with ocelli encircled with black basally. Eyes widely separated, with diameter greater than basal width of lateral ocelli. Thorax: Nota

deep yellow-brown to pale yellow often with darker shading and speckling adjacent to sutures. Forewings length 3.6-4.2mm. Forelegs approximately one and one-half times length of body. Mid- and hindfemora pale yellow to yellow-brown, with sparse black markings. Mid- and hindtibiae usually with black shading and speckling basally extending down to a U-shaped mark at half the tibial length. Hindfemora approximately three-fourths length of hindtibiae and hindtarsi combined. Abdomen: Terga with median transverse black marking, with heaviest pigmentation medially and sublaterally. Sterna with lateral muscle insertion marks black. Subgenital plate with posteriorly produced lateral projections (Fig. 4). Basal swellings of forcep segment two posteriorly directed. Caudal filaments white.

Female adult. Body: Length: 3.2-3.5mm. Coloration pale yellow to yellow-brown with sparse black markings (legs light except for black markings basally and subdistally on the femora and basally extending to the midlength of the tibiae, and caudal filaments light). Head entirely pale yellow to yellow-brown, venter of head with black shading. Forewings length 4.5-5.0mm. Subanal plate well developed into transparent convexity, which extends distally well beyond the bases of caudal filaments.

Diagnosis. Larva: Unknown.

Adult: In both sexes the vertex of the head is entirely pale yellow; the length of the hindfemora is about three-fourths the length of the hindtibiae and hindtarsi combined; and abdominal sterna have paired dark lateral dashes, although these may be faint or not seen on all sterna in extremely pale specimens. The subgenital plate of the male is moderately emarginated with posteriorly produced lateral projections. The subanal plate of the female extends distally, well beyond the bases of the caudal filaments.

Material Examined. Paratype adult parts on slides, Texas, Devil's R, VII-2-1917, PERC; 50+ male and female adults, Texas: Val Verde Co, Devils River at Dolan Falls, VIII-4-1994 and X-17-1995, CR Nelson, NAW, PERC.

Distribution. North America: USA: west Texas.

Remarks. A redescription of the adult stage of *A. texana* has been given herein in order to augment Travers (1935) and address comparative characters now known to be of interspecific importance in *Asioplax*. It should be noted that *A. texana* is only provisionally included in *Asioplax*, pending the discovery of its larva.

Asioplax zunigae, n. comb.

Tricorythodes zunigae Molineri, 2002: 293.

Diagnosis. Larva: Body length 2.0 mm. Maxillae palps present and two-segmented. The setae making up the dorsal transverse row on the forefemora are spatulate. Tarsi lack any blue or blue-black pigmentation basally. Tarsal claws have three to four marginal denticles and paired subapical, submarginal denticles. Abdominal terga lack tubercles. Posterolateral projections of abdominal segment 8 and 9 are well developed with nearly straight lateral margins. Operculate gills are subovate, and their interior ventral lamella is reduced.

Adult: Holotype Male 3.0mm in length, with wing length 3.0mm. The dark longitudinal shading on the thorax and abdomen are important distinguishing characteristics. Hindfemora are subequal in length to the hindtibiae and hindtarsi combined. Females are unknown.

Distribution. South America: Colombia.

Remarks. On the basis of maxillary palpi morphology, similarities in larval body form, coloration and setation, and distinctively large eyes of the male adult, *A. zunigae* appears most closely related to *A. dolani* and possibly the provisional Cuban species *A. sacculobranthis* and *A. sierramaestrae*.

KEY TO LARVAE OF NORTH, CENTRAL, AND SOUTH AMERICAN *ASIOPLAX*

- 1a. Forefemora with dorsal row of short, stout setae (Fig. 2). Maxillae with two-segmented palpi.....2
- 1b. Forefemora with dorsal row of long fine setae [Fig. 1 (Wiersema and McCafferty 2000)]. Maxillae without palpi, or with very short one-segmented palpi.....3
- 2a. Abdominal terga with medial band of black shading. Distribution: Colombia..
.....*A. zunigae*
- 2b. Abdominal terga with paired submedial dark maculae, giving the appearance of paired submedial, longitudinal stripes. Distribution: southeastern U.S.A.....
.....*A. dolani*
- 3a. Abdominal terga with posteromedial tubercles. Distribution: South America. 4
- 3b. Abdominal terga without posteromedial tubercles. Distribution: southwestern U.S.A. to Central America. 5
- 4a. Posteromedial tubercles present on abdominal terga 3-9, larger on terga 6-9. Maxillae without palp. Claws with marginal denticles. Distribution: Ecuador..
.....*A. nicholsae*
- 4b. Posteromedial abdominal tubercles present on terga 7-9. Maxillae with small one-segmented palp. Claws without marginal denticles. Distribution: Argentina, Brazil and Uruguay*A. santarita*
- 5a. Abdominal segment 9 with poorly developed posterolateral projections [Fig. 10 (Lugo-Ortiz and McCafferty 1995a)]. Operculate gills ovate. Anterior lateral setae of mid- and hindfemora longer than posterior lateral setae. Distribution: Costa Rica.*A. curiosus*
- 5b. Abdominal segment 9 [Fig. 2 (Wiersema et al. 2001)] with well developed posterolateral projections. Operculate gills subtriangulate. Anterior and posterior lateral setae of mid- and hindfemora of approximately same length. Distribution: west and south-central North America. 6
- 6a. Tarsi with dark blue pigmentation basally. Claws with paired submarginal denticles. Distribution: West-central Canada; intermountain U.S.A. ...*A. edmundsi*
- 6b. Tarsi not basally pigmented as above. Claws without paired submarginal denticles. Distribution: east and south Mexico; central, south, and west Texas.
.....*A. numinuh*

KEY TO ADULT OF NORTH AND SOUTH AMERICA *ASIOPLAX*

- 1a. Distribution: South America 2
- 1b. Distribution: North America (including Mexico) 3
- 2a. Basal third of wings with black shading. Distribution: Argentina, Brazil, and Uruguay*A. santarita*
- 2b. Black shading limited to costal margin of wings. Distribution: Colombia*A. zunigae*
- 3a. Mid- and hindfemora of male (possibly unknown female) extensively shaded in blue-black (Fig. 1). Vertex of head with posterior lateral areas shaded in blue-black. Distribution: southeastern USA*A. dolani*
- 3b. Mid- and hindfemora not as extensively shaded in blue-black as above. Vertex of head not as above, either entirely shaded in blue-brown to red brown, yellow-brown with epicranial sutures shaded in red-brown, or entirely pale yellow-brown. Distribution: west and south-central North America 4
- 4a. Vertex of head entirely pale yellow to yellow-brown. Hindfemora approximately three-fourths as long as hindtibiae and tarsi combined. Abdominal sternum with lateral dark dashes. Distribution: west Texas*A. texana*
- 4b. Vertex of head not as above. Hindfemora subequal in length to hindtibiae and tarsi combined, similar to Figure 1. Abdominal sternum without lateral dark dashes. Distribution: west and south-central North America.....5
- 5a. Males with tarsi with dark bluish pigmentation basally. Vertex of male head yellow-brown with dark pigmented epicranial sutures and sometimes black speckling; vertex of female head dark brown-black, with pale epicranial suture margins and a pale transverse band at posterior margin of head capsule. Subgenital plate with wide, shallow emargination (Fig. 3). Distribution: west-central Canada; intermountain USA.....*A. edmundsi*
- 5b. Tarsi without dark bluish pigmentation basally [Fig. 3 (Wiersema et al. 2001)]. Vertex of head entirely brown-blue. Subgenital plate with narrow and deep emargination [Fig. 4 (Wiersema et al. 2001)]. Distribution: east and south Mexico; central, south, and west Texas.....*A. numinuh*

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FIRST RECORDS OF ADVENTIVE HYMENOPTERA (ARGIDAE, MEGACHILIDAE, TENTHREDINIDAE, AND VESPIDAE) FROM THE CANADIAN MARITIMES AND THE UNITED STATES¹

E. Richard Hoebeke² and A. G. Wheeler, Jr.³

ABSTRACT: *Arge ochropa* (Gmelin) (Argidae), *Metallus lanceolatus* (Thomson) (Tenthredinidae), *Polistes dominulus* (Christ) (Vespidae), and *Anthidium manicatum* (L.) (Megachilidae), Palearctic species of Hymenoptera previously recorded from North America, are reported from Nova Scotia for the first time. We also report *A. ochropa* from New York as the first record from the United States.

KEY WORDS: Hymenoptera, Nova Scotia, United States, exotic species, new records

Our survey work on adventive insects in Atlantic Canada since 1993 has emphasized the need for additional detection efforts in this region of North America, particularly Nova Scotia, which historically has yielded records of numerous Old World species (Brown 1940; Morris 1983; Hoebeke and Wheeler 1996, 2003; Wheeler and Hoebeke 1997, 2004; Majka and Klimaszewski 2004). The insect fauna of Newfoundland and the Halifax region of Nova Scotia is noted for its unusually large number of unintentionally introduced Palearctic species (Brown 1940, 1950, 1967; Lindroth 1957).

Herein, we report the first collection of four Palearctic species of Hymenoptera from the Maritime Provinces of Canada, and among them, the first U.S. record of *Arge ochropa* (Gmelin), a sawfly known previously in North America only from Ontario, Canada. All collections were made by the authors, unless otherwise noted. The number of specimens examined is given in parentheses after each locality record. Voucher specimens have been deposited in the Cornell University Insect Collection, Ithaca, NY.

ARGIDAE

***Arge ochropa* (Gmelin) (Fig. 1).** This Palearctic sawfly, a destructive pest of ornamental rose (*Rosa* spp.), is widely distributed in continental Europe and ranges from Siberia to the Middle East. The only previous North American records are from Ontario (Smith 1989): Willowdale (1951), Thornhill (1955), Lake Simcoe, Richmond Hill (1957), Agincourt (1957), and Toronto (1963).

New Records: MARITIME CANADA: Nova Scotia: Halifax Co., Halifax, Dalhousie University campus, 4 August 2001, ex *Rosa* sp. (1 female); Halifax Public

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Gardens, 28 July 2003, feeding on ornamental *Rosa* sp. (numerous mature larvae observed, 5 collected and preserved). UNITED STATES: New York: Tompkins Co., Town Of Ulysses, NE of Jacksonville, 18 June 2003, E. R. Hoebeke and M. E. Carter, resting on grass stem near *Rosa multiflora* Thunberg (1 female).

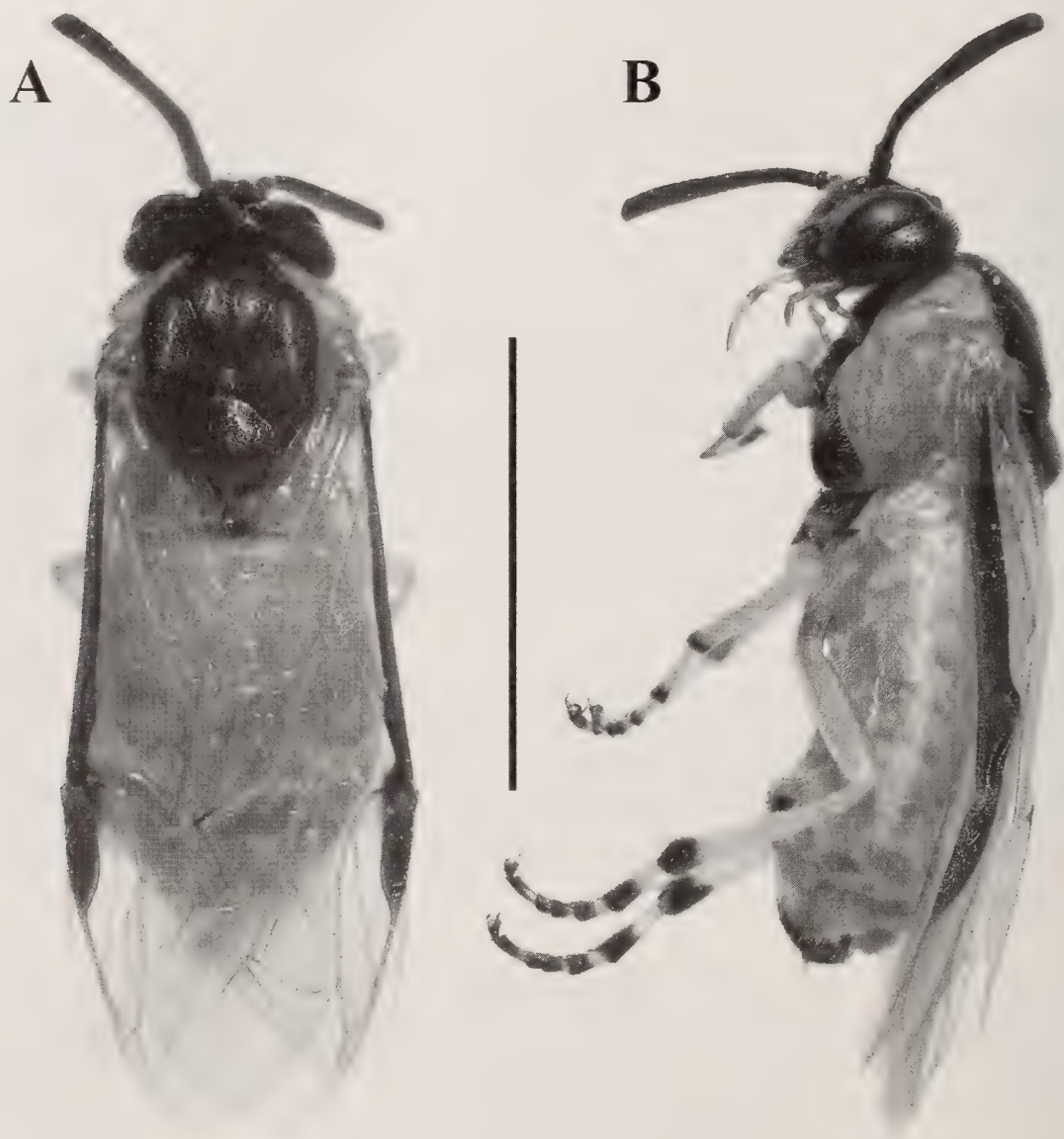


Figure 1. *Arge ochropa*, female. A, dorsal habitus. B, lateral aspect. Scale line = 5 mm.

TENTHREDINIDAE

***Metallus lanceolatus* (Thomson) (Fig. 2).** A Palearctic leafmining sawfly, *M. lanceolatus* has long been recognized as a common pest of native and cultivated *Geum* in English and continental European gardens (Buhr 1933, 1941).

The species was known previously in the European literature as *M. gei* (Brischke); the name was recognized as a junior synonym of *M. lanceolatus* by Koch (1989). This species was originally recorded from North America under a different name – *M. bensoni* Smith; *M. bensoni* also was synonymized with *M. lanceolatus* (Koch 1989). Smith (1971) described *M. bensoni* based on specimens from New York (Albany Co., near Rensselaerville) and British Columbia (Grouse Mt.). *Metallus lanceolatus* has been reported (as *M. gei*) as a pest of *Geum* in cultivated gardens on the campus of Cornell University, Ithaca, NY (Hoebeke 1989), and has been found at other nearby localities (Oswego, NY) (E.R.H., unpublished data). It is the only tenthredinid leafminer of *Geum* in North America. Mature larvae also were collected from mined leaves (Fig. 2C) of *Geum* x *Borisii* and *Geum* ‘Mrs. Bradshaw’ at the Niagara Parks Botanical Gardens and School of Horticulture in Niagara Falls, Ontario, in 1985 (E.R.H., unpublished data).

New Records: MARITIME CANADA: Nova Scotia: Colchester Co., Truro, Nova Scotia Agricultural College (Bible Hill), 29 July 2003, ex *Geum* sp. (larval mines observed, mined leaves not collected). Halifax Co., Halifax Public Gardens, 28 July 2003, ex *Geum* sp. (numerous larval mines observed, but no larvae in mines; mined leaves pressed and vouchered).

VESPIDAE

***Polistes dominulus* (Christ) (Fig. 3).** This Old World paper wasp, abundant in the Mediterranean countries, is rapidly expanding its range in the United States (Cervo et al. 2000, Pickett and Wenzel 2000). It was first discovered in the Boston area (Cambridge) in the late 1970s (Hathaway 1981). Since then, it has been reported from most areas in Massachusetts and has increased its distribution in the United States to include California, Colorado, Connecticut, Maine, Maryland, Michigan, Missouri, New Hampshire, New Jersey, New York, Ohio, Oregon, Pennsylvania, Utah, Virginia, Washington, and Wisconsin (Arduser and Stevens 1999; Landolt and Antonelli 1999; Cervo et al. 2000; Pickett and Wenzel 2000; Kurt M. Pickett, personal communication). In Canada, *P. dominulus* has been collected by the senior author (unpublished data) at two sites in Ontario: Niagara Falls (Niagara Parks Botanical Gardens and School of Horticulture) in 1997 and Brantford in 2002. It also has been sighted at Kingston in 2002 and Sandfield in 2004 (Borkent and Cannings 2004). Borkent and Cannings (2004) recorded the discovery of *P. dominulus* from Saanich and Salmon Arm, British Columbia, in 2003 and 2004, respectively. An undated specimen of *P. dominulus* has been confirmed by K. M. Pickett (personal communication) from Kelowna, British Columbia.

New Record: MARITIME CANADA: Nova Scotia: Cape Breton Co., Sydney (Wentworth Park), 31 July 2003 (1 female).

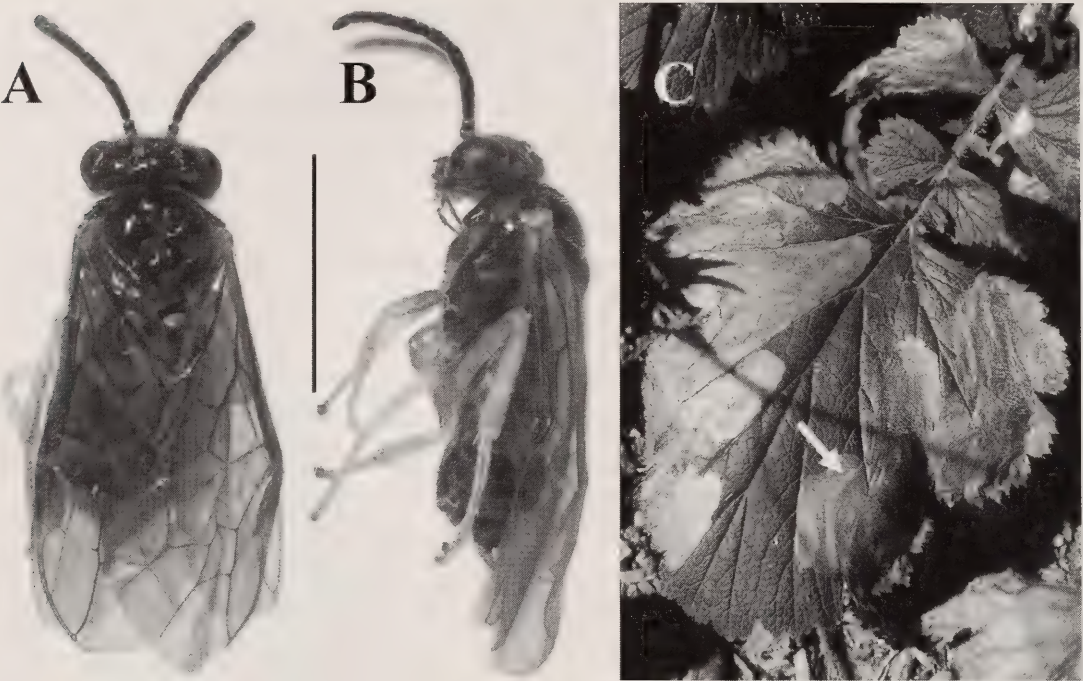


Figure 2. *Metallus lanceolatus*, female. A, dorsal habitus. B, lateral aspect. C, leaf mines in *Geum* sp., larva noted by arrow. Scale line = 2 mm.



Figure 3. *Polistes dominulus*, worker. A, dorsal habitus. B, lateral aspect. Scale line = 5 mm.



Figure 4. *Anthidium manicatum*. A, male, dorsal habitus. B, male, lateral aspect. C, female, dorsal habitus. D, female, lateral aspect. Scale line = 5 mm.

MEGACHILIDAE

Anthidium manicatum (L.) (Fig. 4). The wool-carder bee, a native of Europe, was first found in North America in central New York (3 counties) in 1963 (Jaycox 1967) and since has been found in eastern Ontario (Guelph, Freelon) (Smith 1991). Hoebeke and Wheeler (1999) provided new records of this adven-

tive bee for New York (4 counties), Pennsylvania (2 counties), and Ontario (Niagara Falls). It also was collected in Quebec (Montreal) in 1999 (Payette 2001), and in several counties in northern Ohio between 1996 and 2001, and at one site in southern Michigan in 2001 (Miller et al. 2002). Javorek and MacKenzie (2003) in their "Bees of Maritime Canada" did not record *A. manicatum*; they reported only three introduced species [*Apis mellifera* L., *Megachile rotundata* (F.), and *Osmia lignaria propinqua* Cresson] among 156 species in Maritime Canada.

New Record: MARITIME CANADA: Nova Scotia: Colchester Co., Truro, Nova Scotia Agricultural College (Bible Hill), 29 July 2003, visiting flowers of *Stachys* sp. (3 males, 2 females).

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A NEW OECOPHORID GENUS AND SPECIES (LEPIDOPTERA: OECOPHORIDAE)¹ FROM CHINA

Shu-Xia Wang² and Hou-Hun Li²

ABSTRACT: A new oecophorid genus *Epiracma* is proposed to accommodate two Chinese species: *Epiracma dilatata* sp. nov. and *Epiracma aedeagifera* (Wang, Liu et Li). Photographs of the adults and the genital structures are provided.

KEY WORDS: Lepidoptera, Oecophoridae, *Epiracma*, new genus, new species, China

The genus *Epiracma* gen. nov. is proposed based on the study of the three genera closely related to it: *Irepacma* Moriuti, Saito and Lewvanich, *Ripeacma* Moriuti, Saito and Lewvanich, and *Periacma* Meyrick. The type species, *Epiracma dilatata* sp. nov., is described based on the specimens collected by light trap from Mt. Fanjing, Guizhou Province, China. *Epiracma aedeagifera* (Wang, Liu & Li) is transferred from *Irepacma* to the present genus, with the female described for the first time. The type specimens are deposited in the Insect Collection, College of Life Sciences, Nankai University, Tianjin, China.

Epiracma gen. nov.

Type species: *Epiracma dilatata* sp. nov.

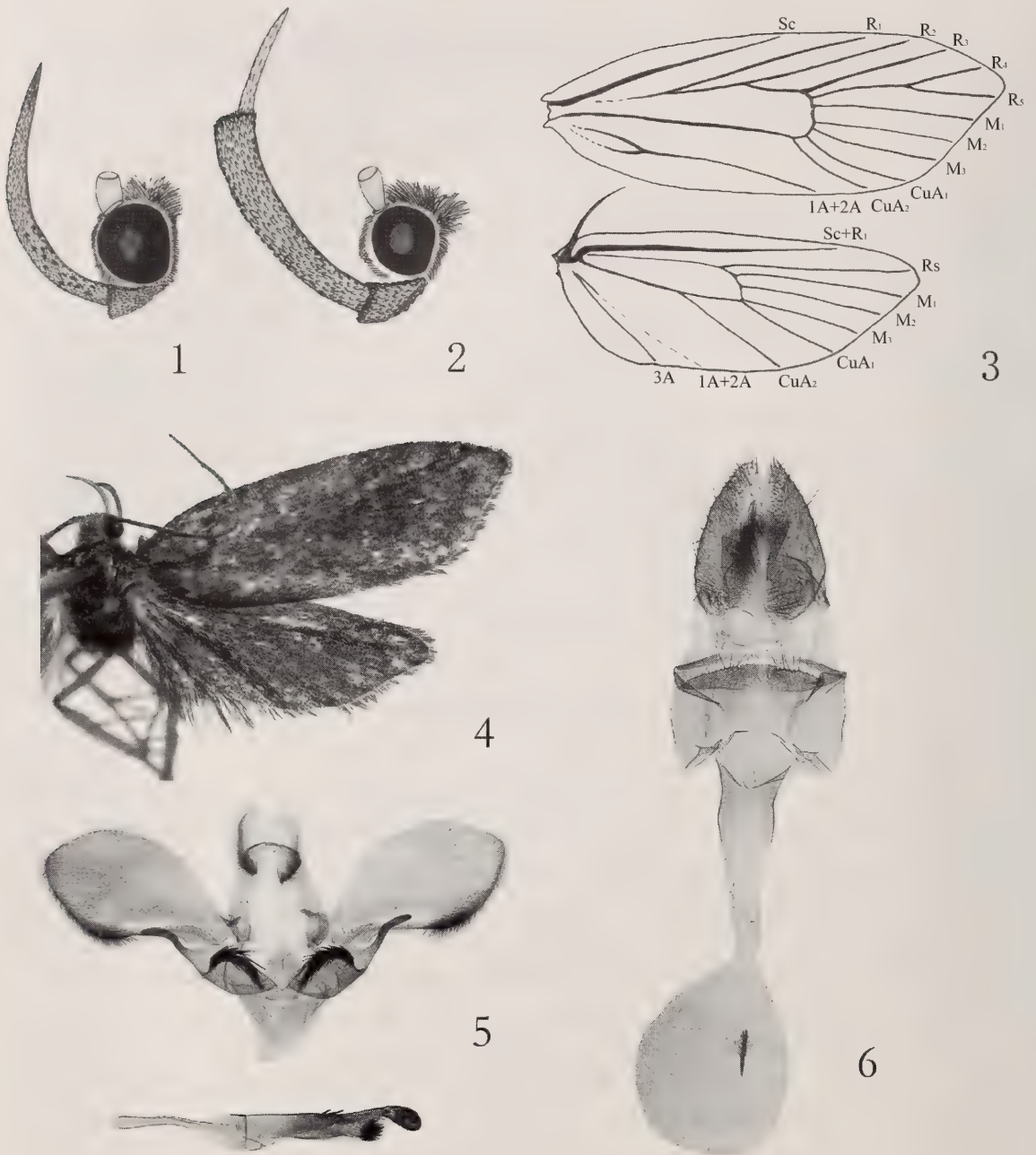
Adult (Figs. 1-3). Head with loosely appressed scales. Antenna filiform, scape without pecten. Labial palpus very long, recurved, thickened with appressed scales; two-segmented in male, three-segmented in female. Forewing broad; costa gently arched; R₁ originating from middle, R₄ and R₅ stalked, R₅ reaching termen, M₃ nearer to M₂ than CuA₁, CuA₁ arising from angle, CuA₂ from before angle, and CuP absent. Hindwing elongate-ovate, M₃ and CuA₁ connate from angle, CuP absent. Abdominal terga with spiniform setae.

Male genitalia: Uncus absent. Gnathos very large, forming an irregularly rounded plate, without lateral arms. Tegumen developed. Valva symmetrical, short and broad, without process or verruca at base of dorsal margin; sacculus developed, dorsally with a cluster of spines in basal part. Transtilla absent. Aedeagus relatively slender, distally with spiniform setae.

Female genitalia: Apophysis anterioris short and strong, large thornlike. Ostium set on the anterior edge of 8th sternum. Ductus bursae partially sclerotized. Corpus bursae with large spine-shaped signum.

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Figs. 1-6. *Epiracma dilatata* gen. nov. and sp. nov.: 1. Head (♂), holotype; 2. head (♀), paratype; 3. wing venation (♂), holotype; 4. adult (♂); 5. male genitalia (Slide No. W01249); 6. female genitalia (Slide No. W01250).

Diagnosis. *Epiracma* gen. nov. is closely allied to *Irepacma* Moriuti et al., *Ripeacma* Moriuti et al. and *Periacma* Meyrick by forewing broad and labial palpus two-segmented in male. However, it can be distinguished from them by uncus absent and gnathos without lateral arms in the male genitalia as well as by apophysis anterioris thick and thornlike in the female genitalia. *Epiracma* gen. nov. can be further separated from its three allies by both male and female genitalia: from *Irepacma* by sacculus dorsally with a cluster of spines and apophysis

anterioris well developed, while sacculus lacks clustered spines and apophysis anterioris is completely absent in *Irepacma*; from *Ripeacma* by transtilla absent and apophysis anterioris strong and thornlike, while transtilla is well developed and apophysis anterioris is obviously long and thin in *Ripeacma*; from *Periacma* by valva without process or verruca at base of dorsal margin and apophysis anterioris thick and thorn-shaped, while valva has well produced process or verruca and apophysis anterioris is long and rather slender in *Periacma*.

Etymology. The generic name is an anagram formed by reordering the letters of the genus name, *Periacma* Meyrick.

***Epiracma dilatata* sp. nov.**

Figs. 4 - 6

Type data. Holotype ♂, China: Mt. Fanjing (27.55° N, 108.41° E), Guizhou Province, alt. 1390 m, 29 May 2002, leg. Xipu Wang, genitalia slide No. W01249. Paratype 1♀, 28 May 2002, other data as for holotype.

Adult (Fig. 4). Wing expanse 17.5 mm. Head orange yellow. Labial palpus orange yellow, tinged with blackish scales on lateral surface of second segment; male second segment becoming slender toward distal end, pointed at apex; female second segment thickened, third segment rather slender, about 1/2 as long as second. Antenna with dorsal surface dark brown, ventral surface grayish yellow. Thorax, tegula and wings evenly dark brown, somewhat deeper in female. Forewing with costal margin slightly arched, termen quite oblique, apex roundly protruded. Legs gray.

Male genitalia (Fig. 5): Uncus absent. Gnathos a large irregularly rounded plate, finely setose and weakly sclerotized along lateral margin, much shorter than tegumen. Tegumen developed, widely band-shaped. Valva broad, more or less elliptical, narrowed at base, bluntly rounded at apex, marginally set with dense fine setae. Sacculus with basal 3/5 broad, somewhat elliptical, edged with a cluster of spiniform setae along dorsal margin; distal process long and slender, slightly curved, apex rounded. Saccus large triangular. Juxta large, its basal portion broadened, distal portion narrowed, posterior margin almost straight. Aedeagus slender, basal 2/5 thin, somewhat handlelike; distal 3/5 thick and straight, with several spines at about 2/3; a small hairy patch set at about 5/6; distal 1/6 a small dilated process.

Female genitalia (Fig. 6): Papilla analis developed, somewhat broadly conical, densely setose. Apophysis posterioris relatively thick, nearly as long as papilla analis. Apophysis anterioris short and strong, thornlike, about 1/4 length of apophysis posterioris. Ductus bursae with basal half thickened and sclerotized, distal half narrow and membranous. Corpus bursae slightly shorter than ductus bursae, somewhat long elliptical in shape. Signum a relatively small sclerotized spine, with one edge dentate, basal plate irregularly quadrangular and weakly sclerotized.

Diagnosis. This species is similar to *Epiracma aedeagifera* (Wang, Liu et Li), but can be distinguished from it by gnathos being much shorter than tegumen, sacculus with distal process not band-shaped and aedeagus distally with a dilated process in the male genitalia; signum relatively small, its basal plate irregularly quadrangular in the female genitalia. In *E. aedeagifera*, the gnathos is nearly as long as tegumen, the sacculus is a strong and curved band-shaped process distally and the aedeagus has a long leaflike process distally in the male genitalia; the signum is large, its basal plate roughly rounded in the female genitalia.

Etymology. This specific name is derived from the Latin *dilatatus* (dilatate), in reference to the distally dilated aedeagus.

***Epiracma aedeagifera* (Wang, Liu et Li, 2002) comb. nov.**

Figs. 7 - 9

Irepacma aedeagifera Wang, Liu et Li, 2002: 64.

Adult (Fig. 7). Wing expanse 20.0-23.0 mm.

Male genitalia (Fig. 8): As illustrated.

Female genitalia (Fig. 9): Papilla analis developed, posterior margin somewhat rounded, setose. Apophysis posterioris stout, nearly as long as papilla analis. Apophysis anterioris about 1/2 as long as apophysis posterioris. Ductus bursae with basal 3/4 heavily sclerotized and parallel sided, distal 1/4 slightly narrow and membranous. Corpus bursae rounded, shorter than ductus bursae. Signum a large spine, with one edge sawlike, basal plate irregularly rounded and sclerotized.

Material examined. Holotype ♂, China: Mt. Qingcheng (30.58° N, 103.31° E), Sichuan Province, 1 June 1979, collector unknown (deposited in the Insect Collection, College of Life Sciences, Nankai University). Paratype 1 ♂, 5 June 1979, other same data as holotype (deposited in the Institute of Zoology, Chinese Academy of Sciences, Beijing, China).

Additional material. 2 ♂♂, 2 ♀♀, China: Mt. Fanjing (27.55° N, 108.41° E), Guizhou Province, alt. 1390 m, 28-29 May 2002, leg. Xinpu Wang.

Distribution. China (Guizhou, Sichuan).



Figs. 7-9. *Epiracma aedeagifera* (Wang, Liu et Li): 7. adult (♀); 8. male genitalia; 9. female genitalia.

Remarks. *Epiracma aedeagifera* (Wang, Liu et Li) is transferred from *Irepacma* Moriuti, Saito et Lewvanich, and its female is described for the first time. This species is characterized by the band-shaped and curved distal process of sacculus in the male genitalia and by the large and long thornlike apophysis anterioris in the female genitalia.

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ANT MIDDEN (HYMENOPTERA: FORMICIDAE) AS AN AIDE IN DOCUMENTING A SPECIES INVENTORY¹

Richard J. Wilson Patrock² and Lawrence E. Gilbert³

ABSTRACT: Two *Pheidole* species considered locally extirpated in a long-term study of the impact of the red imported fire ants were refound in ant midden in the study area. Additional collection information and observations are given on the practicality of using of ant midden as a tool in studying local ant diversity

KEY WORDS: ant midden, fire ants, *Pheidole lamia*, *Pheidole mera*, *Labidus coecus*

Ant midden is refuse material that is comprised primarily of a colony's dead and dispatched enemies, as well as discarded food or other remnants. The contents of a midden pile may not clearly reflect recent feeding or other activities of the ants (Vogt et al. 2001) as much as an accumulation of the trash of activities past, with removal depending on the ant's 'trash day.' While easily overlooked, in central Texas midden is clearly recognizable surrounding the periphery of nests of *Dorymyrmex* and *Pogonomyrmex* colonies. Refuse of the very common red imported fire ant, *Solenopsis invicta* Buren is placed in small patches along trails, usually up to meters away from the mound.

Our interest in midden arises from three applications related to our work (Gilbert and Patrock 2002). We routinely use prepared *S. invicta* midden to monitor for the presence of the introduced biological control agent, *Pseudacteon tricuspis* Borgmeier (Smith and Gilbert 2003) at field release sites. We study the impact of phorid flies on task allocation, including midden work in laboratory colonies (Mehdiabadi et al. 2004). We also monitor for phorid flies around ants associated with midden patches and exposed foraging trails in the field. Finally, since laboratory studies show that dead ants infected with *Pseudacteon* are carried to trash piles in the laboratory, infected workers or heads are likely to be well represented in midden patches in the field.

OBSERVATIONS

In August and September 2004, we collected midden around *Solenopsis invicta* colonies to examine fire ant heads for the presence of *Pseudacteon tricuspis* pupae. Virtually all of this material was funereal and held few other items. We supplemented this sampling with *Dorymyrmex* midden since fire ant bodies and heads are often a large component of this refuse (Hung 1974). One area sampled was the Pitfall trap transect A area [Fig. 1 of (Porter and Savignano 1990)] at the

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Brackenridge Field Laboratory (BFL) where the flies had been seen on a regular basis and the dirt path allowed for relatively easy finding of midden. No evidence of *Pseudacteon* immatures was recovered from any of the material (N=20 piles). Noteworthy, however, were the remains of three ant species in the midden from three *Dorymyrmex* colonies, *Pheidole mera* Wilson, *P. lamia* Wheeler and *Solenopsis geminata* (F.). Voucher specimens are deposited in the entomology collection at the University of Texas.

DISCUSSION

The ant fauna at BFL has been well documented for 30 years (Feener 1978, Porter and Savignano 1990, Chesire 1995, Morrison 2002). Two species we found in midden (*P. lamia* and *P. mera* (as *P. sp. near casta*, S.P. Cover, pers. Comm. 2005, Wilson 2003) were also found by Porter and Savignano but were missed in the follow-up studies of Chesire and Morrison. Both species are patchily distributed, and Feener (1981) describes the historical difficulty in collecting *Pheidole lamia* in particular. Chesire worked in the same vicinity of oak-hackberry overstory used by Feener (1981) in his documentation of *P. lamia* dispersion. The results of his study, suggest that *P. lamia* was absent from this previously well-occupied site described by Feener, perhaps as a result of the prevalent imported fire ant. Morrison (2002) explicitly suggested that fire ants might have contributed to the absence of *P. lamia* in his study. Our recent finding again of the remains of both of these *Pheidole* species indicates that fire ants did not extirpate them but may have helped dramatically reduce their abundance.

One extremely abundant species that had substantially diminished at BFL following the invasion of *S. invicta* was the tropical fire ant, *S. geminata* (Porter et al. 1988). Morrison reported only one set of colonies on the property (near Porter and Savignano's bait transect 5), almost 0.5 km distant to where we found *S. geminata* corpses in midden. Extensive bait, litter and pitfall sampling following Morrison's study indicated that colonies would rarely be found elsewhere on the property. The only other finding was from a set of 200 pitfall traps set out in 2000 where one *S. geminata* worker was caught a few hundred meters to the northeast of our transect.

Solenopsis invicta midden typically holds few corpses of other ant species (Vogt et al. 2001, Patrock, Pers. Obs.), but on one occasion the senior author observed *S. invicta* carrying *Labidus coecus* (Latreille) corpses to midden piles (TX: Kleberg Co., Escondido Tank, 29 March 2000). He then sampled midden piles along two 100 m transects, one running east and the other west from this observation point. *Labidus coecus* was found in 31 of the 40 piles (77.5%), along the entire transect (total measured distance was 194.8m). This species accounted for 671 of the 7654 corpses (8.7%±13.8) with the remainder being *S. invicta* along with two *Pheidole* sp. minors. One callow *S. invicta* had an *L. coecus* worker mandibles attached to its leg.

Measures of local ant species diversity require multiple sampling methods to compensate for collection biases inherent in any specific method (Bestelmeyer et al. 2000). The observations reported here and that of Hung (1974) suggest that the incorporation of *Dorymyrmex* midden searches (dumpster diving) can be an additional tool for documenting a local ant species inventory. Allowing ants to do the initial collecting or scavenging work is likely to be most productive in finding either relatively rare taxa or predominately hypogaeic species such as *Labidus* or *S. geminata*. While species found in a midden are likely to be the garbage host's neighbors, the relative abundance of corpses found will probably be influenced by a host of factors. The age of the corpses should be called into question especially if only disjointed body parts are present. From experience, we view its use to be limited primarily to areas where midden can be readily found, such as on dirt roads and paths and other open areas.

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We thank Sanford Porter and Stephan Cover for their helpful responses to questions concerning localities of collected *Pheidole*. This research was supported in part by the Lee and Ramona Bass Foundation, the Robert J. Kleberg and Helen C. Kleberg Foundation and the State of Texas Fire Ant Research and Management Project (FARMAAC).

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**CHORION MORPHOLOGY OF EGGS OF THE NORTH
AMERICAN STINK BUG *EUSCHISTUS VARIOLARIUS*
(PALISOT DE BEAUVOIS, 1817)
(HETEROPTERA: PENTATOMIDAE):
A SCANNING ELECTRON MICROSCOPY STUDY¹**

Selami Candan,² Zekiye Suludere,² and Fatma Açıkgoz²

ABSTRACT: Eggs of *Euschistus variolarius* (Palisot de Beauvois, 1817) were examined with light and scanning electron microscopes (SEM). Eggs are deposited in clusters of generally 13-14 eggs per mass. The barrel-shaped eggs are about 1.15 mm long and 0.98 mm in width. Newly deposited eggs are light green and darkened color after the onset of embryonic development. The first external evidence of embryonic development is the appearance of paired red eye spots next to aero-micropylar processes. Subsequently the blackish T-shaped egg-burster appears between the eye spots. On the egg surface, polygons formed by spikes are clearly detectable using scanning electron microscopy. This chorionic pattern is usually referred to "as spinose chorion." The circular hatching line surrounds the operculum. There are 30-35 pipe-shaped aero-micropylar projections at the anterior rim of the egg.

KEY WORDS: Heteroptera, Pentatomidae, *Euschistus variolarius*, chorion, external morphology, aero-micropylar process, egg-burster, scanning electron micrographs

INTRODUCTION

The stink bug genus *Euschistus* contains approximately 20 species and subspecies in America north of Mexico (Froeschner, 1988). According to the literature, there are four economically important species: *E. conspersus* Uhler, *E. servus* (Say), *E. tristigmus* (Say), and *E. variolarius* (Palisot de Beauvois) (McPherson and McPherson, 2000; Panizzi et al., 2000). As a result, much information has been published on their biology including description of the immature stages.

Eggs of Pentatomidae have been described by numerous authors (McPherson, 1982; Lambdin and Lu, 1984; Candan and Suludere, 1999 a, b, 2000; Suludere et al., 1999; Wolf et al., 2002 a, b; Danielczok and Kocorek, 2003). One of the earliest and most comprehensive works was that of Esselbaugh (1946) in which he described the eggs of species within several genera, including three of *Euschistus* (i.e., *E. servus*, *E. tristigmus*, and *E. variolarius*). Javahery (1994) authored a study of egg morphology of Pentatomids including two species of *Euschistus* (i.e., *E. servus*, *E. tristigmus*). Recently, Bundy and McPherson (2000) authored a study of the eggs of stink bugs on cotton and soybeans and included electron micrographs of four species of *Euschistus* [i.e., *E. obscurus* (Palisot de Beauvois), *E. quadrator* Rolston, *E. servus*, and *E. tristigmus*]. Finally, Munyaneza and McPherson (1994) authored a comparative study of the

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biology of *E. servus* and *E. variolarius*, including descriptions of the eggs, but did not include SEM micrographs of those eggs.

Here we present detailed examinations of the egg structure of *E. variolarius*, using light and scanning electron microscopes, and compare the results with those of Esselbaugh (1946), Munyaneza and McPherson (1994), Javahery (1994) and Bundy and McPherson (2000)

METHODS

Adults of *E. variolarius* were collected from Campus of Iowa State University (U.S.A) on 16 May 2004 and brought to the laboratory. Ten pairs of adults were placed into polystyrene cages closed by cotton cover and fed on graminaceous plants. Fresh eggs were obtained from a colony maintained in same cage under laboratory conditions (at 25°C and 14 L: 10 D photoperiod) at Michigan State University. The eggs attached to cotton cover were removed and placed on Petri dishes. For SEM study eggs were prepared according to Suludere (1988). Some of the cleaned and dried eggs were mounted with double-sided tape on SEM stubs, coated with gold in a Polaron SC 502 Sputter Coater, and examined with a Jeol JSM 5600 SEM at 20 kV in Kirikkale University Research Centre (Turkey).

RESULTS AND DISCUSSION

The eggs of *E. variolarius* were generally laid in two or three rows or in some cases four or five rows in clusters of 13-14 eggs (12-15) (Fig. 1). They were glued in upright with posterior pole attached to the cotton cover of the containers. Several publications state that the eggs of Heteroptera are deposited upright and attached to each other as well as to the substrate with an adhesive secreted by the female (Southwood, 1956; Cobben, 1968; Hinton, 1981; Javahery, 1994; Candan et al., 2001).

The eggs averaged 1.15 mm in length and 0.98 mm in width. Newly laid eggs were light green at oviposition but then their color changed after embryonic development. It is reported that it is normal for the color of eggs to change during embryogenesis in insects including most of the Pentatomidae (Hinton, 1981; Javahery, 1994).

The first external evidence of embryonic development in eggs of *E. variolarius* is the appearance of paired red eye spots next to aero-micropylar processes. Subsequently the blackish T-shaped egg-burster appears between the eye spots. Eye spots and egg-burster are also partially visible through the thin semitransparent chorion as with *Aelia*, *Mormidea*, *Coenus*, *Graphosoma*, *Piezodorus* species. In other genera, such as *Acrosternum*, *Apateticus*, *Bagrada*, *Carpocoris*, *Eurydema*, and *Perillus* the thickness of the chorion, microsculpture of the egg or color prevent observation of the embryo (Javahery, 1994; Candan, 1997).

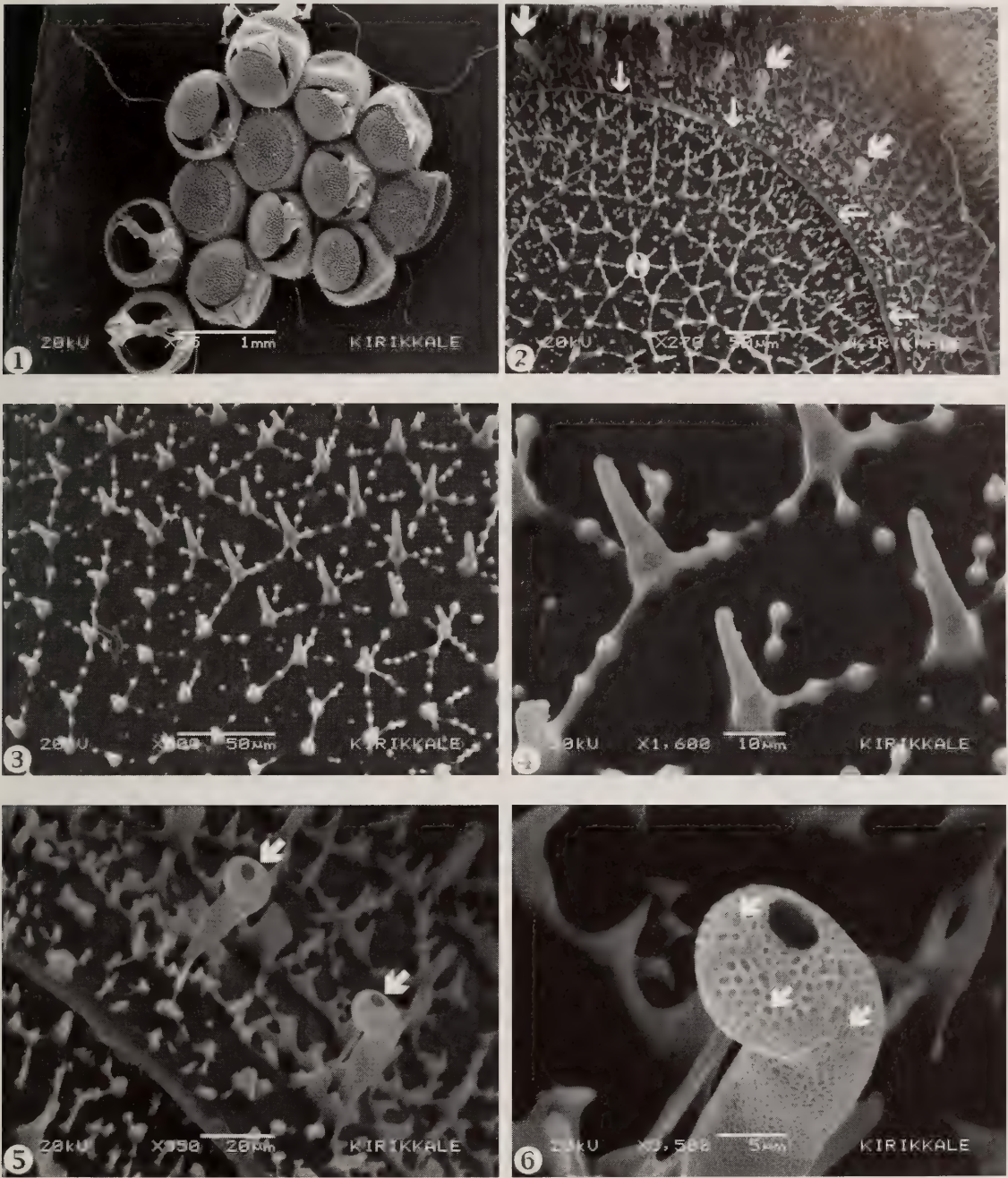


Fig. 1-6. SEM photos of eggs of *Euschistus variolarius* Fig.1. Hatched eggs mass of *E. variolarius*. Fig. 2. Hatching line in a circular shape (→), operculum (O) and micropylar projections (→) Fig. 3-4. Spines connected by web-like chorionic sheets in the polygonal area. Fig. 5. Micropylar projections (→) among the chorionic spines. Fig. 6. Pores (→) on the micropylar projection and micropylar opening.

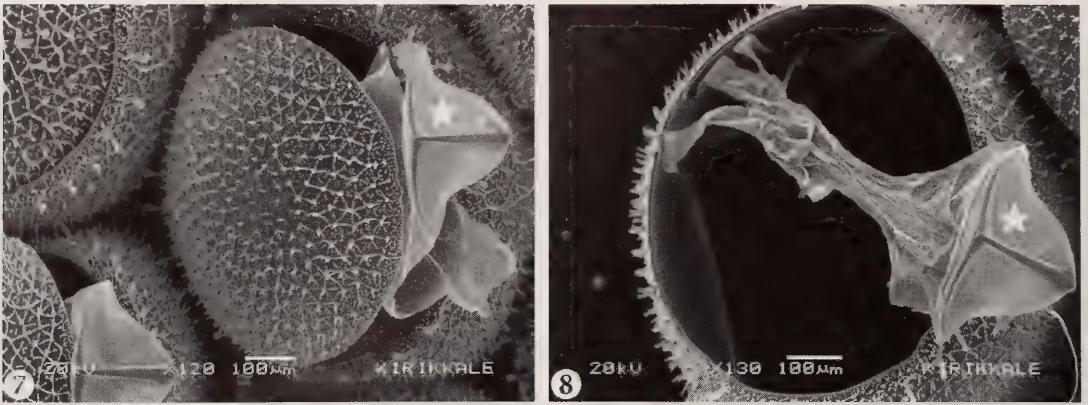


Fig. 7-8. T-shaped configurations of the egg-burster (★) in the hatched egg.

The egg is barrel-shaped and capped by a circular operculum. Chorionic spines are present and connected with somewhat flattened ridges that produce a polygonal reticulated pattern (Fig. 2-4). This chorionic pattern is usually referred to “as spinose chorion.” Some of the spines are short, others long, with acute tips. Similar structures are present on the operculum, which is delimited by eclosion line. The eggs of stink bugs show a variety of species-specific sculpturings. The most common pattern appears to be the so-called spinous chorion typified by spines projecting from the surface, less common surface pattern are referred to as smooth and rough chorion, etc. (Javahery, 1994; Wolf and Reid, 2001, 2003, 2004). This spinous surface pattern has been identified in *Euschistus* species, such as *E. variolarius*, *E. tristigmus*, *E. servus*, *E. euschistoides* Vollenhoven, *E. ictericus* (L.) (Esselbaugh, 1946; McPherson and Paskewitz, 1984; Javahery, 1994; Munyaneza and McPherson, 1994) using light microscopy, and such as *E. obscurus*, *E. quadrator*, *E. servus*, and *E. tristigmus* (Bundy and McPherson, 2000) using scanning electron microscopy.

There are 30-35 long pipe-shaped aero-micropylar projections along the eclosion line discernible among the chorionic spines (Fig. 5, 6). In *E. variolarius* eggs, the number of micropylar processes has been reported as 28-37 (Esselbaugh, 1946) and 27-33 (Munyaneza and McPherson, 1994). Including *E. variolarius*, all examined species of *Euschistus*, including *E. obscurus*, *E. quadrator*, *E. servus*, *E. tristigmus*, and *E. ictericus* have 26-39 micropylar processes (Esselbaugh, 1946; McPherson and Paskewitz, 1984; Munyaneza and McPherson, 1994, Bundy and McPherson, 2000). The egg shape, chorionic pattern, egg-burster as well as the number of micropylar projections has taxonomical importance (Puchkova, 1966; Hinton, 1981). In *E. variolarius* eggs, the surface of aero-micropylar projections is sponge-like and it has numerous pores. Aero-micropylar openings are clearly visible on the tips (Fig. 5, 6). The micropylar process has a central canal for the passage of sperm that becomes cemented when the egg is laid. The rest of the process has a porous structure that serves for respiratory interchange (Southwood, 1956; Cobben, 1968; Hinton, 1981; Javahery, 1994).

A T-shaped, blackish, egg-burster is visible before hatching, and has a definite and sclerotized structure. An eclosion line is clearly visible with SEM (Fig. 1, 7, 8). Hatching begins with peristaltic contraction of the nymph's body, posteroanteriorly. The egg burster does not separate from the egg during hatching but it remains attached basally to the inner side of the egg (Fig. 7, 8). T-shaped egg-bursters have been reported in the Pentatomidae (Schumacher, 1917; Esselbaugh, 1946; Southwood, 1956; Puchkova, 1959, 1966; Cobben 1968; Javahery, 1994; Candan, 1997; Candan et al., 2001). Until now, no SEM micrograph of other *Euchtiscus* species have been showed, it's the first time to show egg-burster of one of the *Euchtiscus* species by SEM in this study.

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***SYMPIESIS FRAGARIAE* (HYMENOPTERA:
EULOPHIDAE) PARASITIZES *MALACOSOMA
AMERICANUM* (LEPIDOPTERA: LASIOCAMPIDAE)
IN KENTUCKY, U.S.A.:
HOST AND GEOGRAPHIC RECORDS¹**

B. A. Choate and L. K. Rieske²

ABSTRACT: *Sympiesis fragariae* emerged from a single, field collected *Malacosoma americanum* tent during the spring of 2004 in central Kentucky. This is the first report of *S. fragariae* parasitizing *M. americanum*, as well as the first report of this parasitoid within Kentucky.

KEY WORDS: eastern tent caterpillar, parasitoid, Eulophidae, Mare Reproductive Loss Syndrome

The genus *Sympiesis* is found worldwide. Throughout North America members of the *Sympiesis* genus parasitize various Coleoptera, Diptera, Hymenoptera, and Lepidoptera (Noyes 2003). *Sympiesis fragariae* Miller, parasitizes both lepidopteran larvae that live within cases during their development and pupae that occur within cocoons (Miller 1970, Krombein et al. 1979). Reported lepidopteran hosts of *S. fragariae* include: *Hemerophila pariana* Clerck (Choreutiidae), *Coleophora malivorella* Riley (Coleophoridae), *Anthopila pariana* (Clerck) (Glyphipterygidae), *Thyridopteryx ephemeraeformis* (Haworth) (Psychidae), *Tetralopha robustella* Zeller (Pyralidae), *Ancylis comptana* (Froelich) (Tortricidae), and *Argyrotaenia velutinana* (Walker) (Tortricidae) (Krombein et al. 1979, Noyes 2003). Distribution records within the United States include Connecticut, Delaware, Georgia, Kansas, Maryland, Ohio, Pennsylvania, Virginia, Wisconsin and West Virginia (Krombein et al. 1979, Noyes 2003).

In the spring of 2004, *S. fragariae* was discovered parasitizing the pupae of a novel Lasiocampidae host, the eastern tent caterpillar, *Malacosoma americanum* (Fabricius). *M. americanum* is a common, native Lepidoptera found throughout the eastern United States feeding on rosaceous hosts. Amongst the branches of host trees, larvae communally construct silken tents that serve as the central location from which group foraging bouts are launched (Dethier 1980, Fitzgerald and Willer 1983). Since 2001, *M. americanum* larvae have been implicated in early fetal losses and late term foal abortions associated with Mare Reproductive Loss Syndrome (Webb et al. 2004). Thus, there has been increased interest in *M. americanum* management, including enhancement of natural enemies.

Between 7 April 2005 and 13 May 2005, *M. americanum* tents were sequentially sampled from two black cherry-dominated fencerow sites to characterize associates and assess parasitoid impact (Choate and Rieske *In press*). Beginning 13 d post hatch (7 April) six naturally occurring tents, which contained variable

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numbers of larvae, were collected at 3-5 d intervals from the lower (1.9-4.5 m) and upper (4.75-12.5 m) tree canopy; and the north and south sides of the fencerow. Tents, caterpillars, and associated branches of foliage were immediately transferred to the greenhouse (23°C, 12:12 L:D), and placed within darkened cylindrical mesh cages (30.5 x 61 cm) fitted with a collection vial. Larvae were provided fresh black cherry foliage as needed. All predators, parasitoids and inquilines were removed from collection vials at 24 h intervals and placed in 70% ethanol until identification. Steve Krauth identified all collected parasitoids and deposited vouchers in the University of Wisconsin Insect Research Collection.

A total of 82 parasitoids emerged from 56 collected tents. Two *S. fragariae* emerged from a single tent containing 5 *M. americanum* pupae on 20 May 2004. The tent was collected at a height of 2 m from the north side of a black cherry tree (*Prunus serotina* Ehrhart) in central Kentucky (Fayette Co.) on 10 May 2004. The most prevalent species in our collections was *Hyposoter fugitivus* (Say), a larval parasitoid (Choate and Rieske *In press*).

Various parasitoids have been identified as impacting *M. americanum* pupal development, including several Eulophidae: *Dimmockia incongrua* Ashmead, *Syntomosphyrum clisiocampae* Ashmead, and *Syntomosphyrum esurus* Riley, identified from West Virginia populations (Kulman 1965). An unknown *Sympiesis* species has been noted as a pupal parasite of the closely related forest tent caterpillar, *Malacosoma dissstria* (Witter and Kulman 1979), which is also found within Kentucky.

This is the first record of *S. fragariae* on *M. americanum* and the first report of its occurrence in Kentucky.

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SCIENTIFIC NOTE

**DISCOVERY OF THE MILLIPED, *AUTURUS LOUISIANUS*
LOUISIANUS (CHAMBERLIN, 1918), IN TEXAS
(DIPLOPODA: POLYDESMIDA: EURYURIDAE)¹**Chris T. McAllister² and Rowland M. Shelley³

The North American milliped genus *Auturus* Chamberlin, 1942 (Polydesmida: Euryuridae) consists of four species, three in the midwest, primarily along the Mississippi River, and one in the southeastern states. The last, *A. erythropygos* (Brandt, 1841) (syn. *A. georgianus* Chamberlin, 1942), inhabits the Atlantic Coastal Plain and Piedmont Plateau from Lunenburg County, Virginia,⁴ to Levy County, Florida, and comprises two subspecies, the nominate, occurring from Virginia to Chatham County, Georgia, and *A. e. becki* Chamberlin, 1951, in Florida and doubtlessly also southern Georgia (Shelley 1978a, b, 1982, 1990, 2000, 2001; Filka and Shelley 1980; Hoffman 1999). Of the three midwestern species, *A. mcclurkini* Causey, 1955, occurs exclusively east of the Mississippi River in Mississippi and western Tennessee, while the other two span the water-course, occurring westward to the edge of the Central Plains. *Auturus evides* (Bollman, 1887), ranges from the vicinity of Minneapolis, Minnesota, to the Arkansas River in Arkansas and Oklahoma and extends eastward to eastern Illinois, and *A. louisianus* (Chamberlin, 1918) extends southward from the Arkansas River to southern Louisiana and Mississippi (Shelley 1982, Hoffman 1999). The latter also comprises two subspecies, the nominate occurring west of the Mississippi River in Arkansas, Oklahoma, and northern Louisiana, and *A. l. phanus* Chamberlin, 1942, occurring to the east in Mississippi and southeastern Louisiana. *Auturus l. louisianus* is abundant in central and southern Arkansas, southeastern Oklahoma, and northern Louisiana (Shelley 1982, McAllister et al. 2002a, b, 2003), and Shelley (1982) predicted discovery in the northeastern corner of Texas, which is compatible with known occurrences in the adjoining states. Repeated efforts to document occurrence in Texas have been unsuccessful, but as euryurids occur almost exclusively in association with moist, decaying hardwood logs and stumps, particularly under bark, they are among the few millipeds that one can deliberately search for with a reasonable chance of success. On 20

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⁴ Based on an unpublished sample at the Virginia Museum of Natural History, Martinsville. Sample data: VIRGINIA: *Lunenburg Co.*, south bank Nottoway R. below Nottoway Falls, in rotting birch log, 2♂, ♀, 14 April 1990, R. L. Hoffman, leg.

February 2004, a sample of this milliped was collected in litter under an oak log in Cass County to confirm northeast Texas for *A. l. louisianus*; the site is about 1 mi (1.6 km) west of the Arkansas state line (at Miller County, where the species is currently unknown). Locality data are as follows; the specimens are housed in the invertebrate collection of the North Carolina State Museum of Natural Sciences:

TEXAS: *Cass Co.*, ca. 6 mi (9.6 km) NE Atlanta, along FM rd. 3129, 0.5 mi (0.8 km) N Bloomburg, 6♂, 5♀, 4 juveniles., 20 February 2004, Z. D. Ramsey. **New State Record.**

ACKNOWLEDGEMENTS

We thank R. L. Hoffman (Virginia Museum of Natural History, Martinsville, Virginia), for a pre-publication review and permission to cite the Lunenburg County, Virginia, record of *A. e. erythropygos*.

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SCIENTIFIC NOTE

NOTES ON *LEUCTRA ALTA*
(PLECOPTERA: LEUCTRIDAE)¹Scott A. Grubbs²

James (1974, 1976) described five species of stoneflies from limited geographical areas in Alabama, including four species of *Leuctra*. One of those species, *L. alta* James, has been recorded only from two Alabama counties (Stark and Harris, 1986; Kondratieff and Baumann, 2000). During the course of a comparative life history study of several species of stoneflies from a temporary stream-perennial spring continuum in central Kentucky, repeated collecting for adults revealed two species of markedly different sizes that resembled *L. sibleyi* Claassen. The larger species was determined as *L. sibleyi* and the smaller species was indistinguishable from paratype males of *L. alta*. Both *L. alta* and *L. sibleyi* were common inhabitants of the spring-fed reach, occurring at a *L. alta*:*L. sibleyi* ratio of 2:1. In contrast, *L. alta* was found near-exclusively in the temporary stream at a ratio of 144:1.

Additionally, both Stark (2001) and Grubbs (2004) reported *L. sibleyi* as a member of the stonefly fauna of Indiana. During the latter study fresh material was collected from springs and temporary streams in the southern portion of the state and determined as *L. sibleyi*. Reexamination of this material and comparative assessment with the paratype males revealed that *L. alta* was collected from two temporary streams and the remaining specimens were of *L. sibleyi*. In addition, examination of Illinois material from the Illinois Natural History Survey (INHS) also revealed the presence of *L. alta* from the far southern portion of that state. The Kentucky, Illinois, and Indiana localities of *L. alta* all represent new state records and the prior *L. sibleyi* county records of Harrison and Ohio in Indiana (Grubbs, 2004) now refer to *L. alta*. The Alabama paratypes of *L. alta* are deposited in the Auburn University Entomological Museum (AU) and all Indiana and Kentucky material in the S. A. Grubbs collection at Western Kentucky University (WKU).

Material Examined. Alabama: Calhoun Co., Camp Cottaquilla Rd., off Ala. 9, N jct. U.S. 78, 14 April 1972, A. James and A. Burnett, 2 ♂ paratypes (AU); Illinois, Pope Co., Bell Smith Springs, 29 April 1949, Sanderson and Stannard, 1 ♂ (INHS); Indiana, Harrison Co., tributary to Potato Run, 6 km E Leavenworth, 16 May 2000, S. A. Grubbs (SAG) and D. E. King-Grubbs, 3 ♂, 5 ♀ (WKU); Ohio Co., tributary to Willow Creek, 5 km NW Enterprise, 4 May 2002,

¹ Received on February 8, 2005. Accepted on March 8, 2005.

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SAG, 1 ♂ (WKU); Kentucky, Hart Co., tributary to Roundstone Creek, 7.5 km NW Bonnieville, 10 May 2000, SAG, 10 ♂, 15 ♀ (WKU); same but 30 April – 4 June 2002, SAG, 44 ♂, 60 ♀ (WKU); same but 24 April – 23 May 2003, SAG, 44 ♂, 25 ♀ (WKU); same but 28 April 2004, SAG, 6 ♂, 2 ♀ (WKU).

ACKNOWLEDGMENTS

Thanks are extended to Wayne Clark, Auburn University, for the loan of paratype material, Ed DeWalt, Illinois Natural History Survey, for kindly yielding the Illinois record, and Peter Harper, University of Montreal, for confirming the validity of *Leuctra alta*. Boris Kondratieff, Colorado State University, Ed DeWalt, and three anonymous reviewers provided constructive comments on an earlier version of this note.

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SCIENTIFIC NOTE

FIRST RECORD OF *TRIOZOCERA VERNALIS* KIFUNE AND BRAILOVSKY (STREPSIPTERA: CORIOXENIDAE) FROM THE UNITED STATES, WITH ADDITIONAL RECORDS FOR STREPSIPTERA IN SOUTH CAROLINA¹Will K. Reeves² and Jerry L. Cook³

While some species of Strepsiptera could be agents of biological control, they are poorly studied as a group. The distribution and hosts of most Nearctic Strepsiptera are inadequately documented and no previous reports have focused on the strepsipteran fauna of South Carolina. We examined the strepsipterans in the Clemson University Arthropod Collection (CUAC) and potential hymenopteran and hemipteran hosts to determine if previously undetected stylopized specimens were present. Five species of Strepsiptera were identified in the CUAC including, *Elenchus koebelei* Pierce, *Halictophagus* sp., *Triozocera vernalis* Kifune and Brailovsky, *Xenos pallidus* Brues, and *Xenos peckii* Kirby.

Two vials of unidentified male Corioxenidae from Upper Three Runs Creek, Aiken County, South Carolina, collected on 29 July 1984 were examined and initially identified as *Triozocera mexicana* Pierce. *Triozocera mexicana* is a widely distributed species ranging throughout the southern United States and Mexico (Kifune and Brailovsky, 1987a; Kathirithamby and Peck, 1994). The wing venation and size of the specimens were unusual and upon closer inspection and comparison to reference specimens all of the *Triozocera* were identified as *T. vernalis*. *Triozocera vernalis* was known from Mexico only (Kifune and Brailovsky, 1987b, 1991). This represents the first records of *T. vernalis* from the United States and casts some doubt on the identifications of *T. mexicana* in the southern United States. Additional material identified as *T. vernalis* were collected from a spring creek above Camp Eunice approximately 1.1 km south southeast of Roberta, Crawford County, Georgia, on 4 and 28 August 1983.

Four additional species of Strepsiptera were in the collection. These included *E. koebelei*, a widely distributed parasite of Cicadellidae and Delphacidae (Kathirithamby and Peck, 1994; Kathirithamby and Moya-Raygoza, 2000). While not previously reported from South Carolina this strepsipteran ranges from the Galapagos to Costa Rica and Mexico north to Ohio and east to Maryland (Kifune and Brailovsky, 1987a; Peck and Peck, 1989; Kathirithamby and Peck, 1994). We report two collections of *E. koebelei* from 6-21 November 1981 in Clemson, Pickens County, ex *Sogatella kolophon* (Kirkaldy) (Hemiptera: Delphacidae).

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We discovered stylopized *Cuerna costialis* (Say) (Hemiptera: Cicadellidae) with an unidentified *Halictophagus* sp. collected from Clemson on 2 December 1981 and 7 May 1985. *Halictophagus* spp. were not known from South Carolina, but *Halictophagus acutus* Bohart, *Halictophagus omani* Bohart, and *Halictophagus oncometopiae* (Pierce) have been reported in the southeastern US (Kifune and Brailovsky, 1987a; Kathirithamby and Peck, 1994).

Two species of *Xenos* were identified. A single female *X. pallidus* stylopized an unidentified *Polistes* collected from Clemson, Pickens County, on 25 November 1983 and two female *X. peckii* stylopized *Polistes fuscatus* (Fabricius) collected in Clemson on 19 and 25 June 1985. Neither species of *Xenos* were previously reported from South Carolina but *X. peckii* parasitizes *Polistes metricus* Say in northeast Georgia (Hodges et al. 2003).

Additional strepsipterans are reported from neighboring states and undoubtedly occur in South Carolina. For example, *Caenocholax fenyesei* Pierce, a parasite of *Solenopsis invicta* Buren was reported from an adjacent county in Georgia (Cook et al. 1997). Five additional species, *H. acutus*, *H. omani*, *H. oncometopiae*, *Pseudoxenos louisianae* (Pierce), and *T. mexicana*, have been reported from nearby southern states (Kifune and Brailovsky, 1987a; Kathirithamby and Peck, 1994).

We thank James Korecki for loaning material from the CUAC and Charles Bartlett for identifying *Sogatella kolophon*. Voucher specimens have been deposited at the CUAC.

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BOOK REVIEW

THE TARANTULA SCIENTIST by Sy Montgomery. Photographs by Nic Bishop. 2004. Houghton Mifflin. Boston, Massachusetts, U.S.A. 80 pp. ISBN 0-618-14799-3. US\$18.00.

The latest in the highly regarded "Scientists in the Field" series, this exciting new book from award-winning writer Sy Montgomery lets readers tag along with tarantula specialist Sam Marshall of Hiram College (Hiram, Ohio, U.S.A.) on a field trip to French Guiana.

Montgomery made an excellent choice in her enthusiastic subject, as Marshall has a gift for making clear that scientific research is something almost anyone can do. "Scientific research is just a way of asking a question and answering it," he says. Reinforcing that scientists are also regular people, Sam naps in his hammock and later falls down a slope after being stung by wasps. He good-heartedly explains that he was a poor student in school until he found his passion.

The book's opening moments find Sam in French Guiana (South America) enticing a Goliath bird-eater tarantula from its nest. His fun attitude to his subject shows. "Come out with your tarsi up!" he says. And when the expedition arrives at a steep incline, a likely site for tarantula dwellings, he explains, "They like a room with a view."

Why Sam is measuring and weighing tarantulas, and counting the number in a series of quadrants, is clearly explained. We find out that there are 850 extant species of tarantulas worldwide, that they use silk although they don't make webs, and that in some places people roast and eat tarantulas. The text follows the use of a scanning electron microscope to examine leg hairs, also known as setae, in a study to determine how Goliath bird-eater tarantulas make hissing sounds.

Readers also visit Sam's Spider Lab back in Ohio, "the only comparative tarantula lab in the world that's global in reach." The lab has 500 living spiders. As usual in this series, young people are shown participating in research.

The images in this book are excellent. Biologist-photographer Nic Bishop's marvelous stop-action shots capture a New World tarantula brushing hairs from its abdomen, and a colorful *Pterinochilus* rearing up aggressively. An *Avicularia* spider lies in its silken hammock to molt. An important section walks readers through kingdom, phylum, class, order, and family, to explain where tarantulas fit in, and provides close-ups of body parts. Many captions include family or common names.

Montgomery wisely includes information on handling tarantulas, and discourages keeping them as pets. There is also a glossary and index, suggested further reading, and websites suitable for children. For ages 9 to 14.

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BOOK REVIEW

MANUAL DE ETNOENTOMOLOGÍA. 2002 by Eraldo Medeiros Costa-Neto. M & T. Manuales & Tesis. 4. SEA (Sociedad de Entomología Aragonesa). Zaragoza, Spain. 104 pp. ISBN (volume): 84-932807-1-2. Paperback. In Spanish.

Long ago, I was introduced to ethnoentomology through a Taíno-Spanish dictionary. In the early 2000s, while requesting collecting permits from and interacting with Native Americans of the Zia and Jemez Pueblos of northern New Mexico (U.S.A.), I had not noticed insects as being an obviously important element in their cultures. Last summer 2004, just as the Smithsonian's Museum of Native American Indians was being inaugurated, I began wondering about ethnoentomology or the interdisciplinary study of relationships between "insects" and human culture (p. 3) and decided to plunge into the field to discover the major structure of what has been written on the subject. In doing so, I came across a growing body of literature, journals, and groups devoted to this field. One of the books I found was the Spanish-written *Manual de Etnoentomología* (Ethnoentomology Manual) by the Brazilian biologist Eraldo Medeiros Costa-Neto.

The *Manual* is divided in four parts, following major fields of interest in the ethnoentomological literature. In Part 1 (chapters 1-3), Costa-Neto describes the history and distinct theoretical approaches to ethnoentomology in, at least two, axes: 1) the role of cultural comparisons in ethnoentomological research and 2) the role of "use" of an insect. In an emic approach, the researcher views human-'insect' interactions from the local culture's point of view. On the other hand, the outsider's approach (etic) takes into consideration the researcher's analysis, where s/he perceives the cultural organization according to his/her own terms. Both methodological perspectives have different data collection and analysis protocols (E. M. Costa-Neto to Santiago-Blay, pers. comm., May 2005), and 2) what is the relative importance of use of an "insect" in the culture being studied (utilitarian or intellectualist approach). As traditional entomological knowledge (TEK) is much older than the scientific knowledge of insects, TEK is potentially useful to humanity (chapter 3).

Part 2 (chapter 4) includes a discussion of "what is an 'insect.'" The cultural concept, "insect," needs not to coincide with the notion used by scientists. Furthermore, human attitudes toward "insects" may vary immensely. Of course, fomenting the destruction of "insects" can be particularly detrimental for threatened or endangered species.

Part 3 (chapters 5-8) includes a classification or typology of the plethora of human – insect interactions: language, the arts, entertainment, prediction of future events, sexuality, sociology, domestication, bioindicators, source of smells, education, science, nutrition (including some interesting recipes, chapter 6), source of medicinal remedies (chapter 7), and religion (chapter 8). In reading these chapters, memories of radio and television advertisements as well as popular films that depict insects and/or entomologists in less than the best possible light, crossed my mind. A great feature of the *Manual* is its great breadth of examples, both geographically and temporally.

Part 4 (chapters 9-10) discusses methods in ethnoentomology. The *Manual de Etnoentomología* concludes with a Code of Ethics of Ethnobiology (www.sbee.org.br, pp. 90-92) and a substantial References section (pp. 93-104). For the novice in the field, like me, this volume does an excellent job summarizing the field in clear and simple fashion.

ACKNOWLEDGMENTS

The author of the *Manual de Etnoentomología*, Eraldo Medeiros Costa Neto (Universidade Estadual de Feira de Santana, Departamento de Ciências Biológicas, Feira de Santana, Bahia Brasil) kindly reviewed this piece and offered clarifications.

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RECENTLY PUBLISHED BOOKS BRIEFLY NOTED

Jorge A. Santiago-Blay¹

From DNA to diversity. Molecular genetics and the evolution of animal design.

2005. S. B. Carroll, J. K. Grenier, and S. D. Weatherbee. Blackwell Publishing. Malden, Massachusetts, U.S.A. 258 pp.

Excellent work featuring the importance of developmental regulation in evolution or "evo-devo." This is an easy-to-read tome containing excellent illustrations and bibliographies at the end of every chapter. From DNA to Diversity features numerous examples on arthropods and insects. Undergraduate and graduate students will enjoy this entrée into the vast and often complex literature.

Frontiers of biogeography. New directions in the geography of nature. 2004.

M. V. Lomolino and L. R. Heaney. Sinauer Associates, Inc. Sunderland, Massachusetts, U.S.A. Published in association with the International Biogeography Society. 436 pp.

Excellent collection of papers written by over 30 colleagues, many of them familiar names in different branches of ecological and evolutionary biogeography. Among many valuable contributions, there is a global plate tectonic tree diagram (pp. 10-11 and plates 1-18), numerous examples of techniques used to link biological and environmental variables through time, papers researching phylogeographic and global patterns both on land and in the sea.

The fire ant wars. 2004. J. B. Buhs. The University of Chicago Press. Chicago, Illinois, U.S.A. 216 pp.

This work follows the march of the red imported fire ants (*Solenopsis invicta* Buren, Formicidae) from South America in the early 20th century to the U.S.A. with special interest in the "politics" of the practices to control it.

Morphology, shape and phylogeny. 2002. N. MacLeod and P. L. Forey (Editors). Systematics Association Special Volume Series 64. Taylor & Francis, London, England, United Kingdom. 308 pp.

A collection of excellent papers by many of the leaders in the field of morphometrics and its impact on phylogenetic analyses.

The rarest of the rare. Stories behind the treasures at the Harvard Museum of Natural History. 2004. Text by N. Pick. Introduction by E. O. Wilson. Photographs by M. Sloan. Harper Collins Publishers Inc., New York, NY, U.S.A. 178 pp.

Fascinating story of natural history through the lens of the research efforts of scientists at Harvard University and its Museum.

Assembling a tree of life. 2004. J. Cracraft and M. J. Donoghue. Oxford University Press. Oxford, England, United Kingdom. 576 pp.

A collection of thought-provoking essays by leading workers in biodiversity. Excellent breadth of coverage, from bacteria and archaeans to animals.

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SOCIETY MEETING OF FEBRUARY 23, 2005

The Jeweled Metamorphosis

Faith B. Kuehn, Plant Industries, Delaware Department of Agriculture

Beginning the year on a different note, Dr. Faith Kuehn explored the use of the insect image in jewelry during the first Society meeting of 2005. Scarab representations of Re, the sun god who rolled the sun across the sky, were among the earliest uses of insects in jewelry. Later, jewelry assumed a more decorative role, and insects worn for adornment conveyed a symbolic meaning. For example, the cicada represented rejuvenation and rebirth, the dragonfly swiftness, and the fly persistence and bravery. In some cultures, such as Native American tribes in California and tribes in southern Africa, moth cocoons with added sand or seeds were used as decorative rattles. The 19th century brought a period of "ornithological and entomological fevers," and jeweled insect adornments of hats, dresses and vests were extremely popular. Led by Rene Lalique, Art Nouveau in the early 20th century brought jewelry into the realm of wearable art versus wearable jewels. Lalique worked in a stylized realism, and reflecting the contemporary interest in Japanese art, created jewelry using dragonflies, cloisonné, and relatively humble materials such as horn, bone and ivory.

Dr. Kuehn has also visited contemporary jewelry artists in their studios to observe and discuss how they are incorporating insects in their work. Among contemporary jewelry artists, the shape, color and texture of the insect body, along with many of its behavioral traits, continue to serve as a rich source of inspiration. The pieces may be realistic, employing wings and elytra or the entire body of the insect. Some artists use precious metals while creating anatomically correct works, including features such as articulating appendages. Others use highly stylized forms and a wide array of found objects.

Although to some entomological enthusiasts insect jewelry may seem merely a decoration and of trivial interest, Dr. Kuehn emphasized that this jeweled art can play a much more important role in a society that is increasingly separated from nature. Insect jewelry, as an art form, can help to shorten the psychic space between insects and humans. Art illuminates an object, encourages us to take a closer look, to pause and reflect. As such, it is a good medium to reach out to the public and encourage them to take a closer look at the wide and fascinating world of insects.

Several Cornell drawers and display boxes from Dr. Kuehn's collection were set up to accentuate the evening's talk. Displays included Lucanidae, Coccinellidae, the *Morpho* group of butterflies, "Entofantasia" (fantasy insects of unknown taxonomy), Jewel Beetles (Buprestidae and Scarabaeidae), and "Broad-sides from Other Orders." Complementing Dr. Kuehn's displays, Dr. Dennis Bartow brought in a display of buttons spanning several centuries that illustrate insect themes.

In other news, Jason Weintraub reported the rearing of a buprestid beetle, *Cypriacis aurulenta* (Linnaeus), a species known from western North America, from a piece of Ponderosa Pine (*Pinus ponderosa*) wood in a workshop in Chester County, Pennsylvania (the specimen is now in the Academy of Natural Sciences collection). Jon Gelhaus and Greg Cowper brought in a live specimen of the Pink Web-spinner, *Haploembia solieri* (Rambur) in the order Embiidina (= Embioptera) for members to observe. This order is unknown in the Northeast. Several of these insects were collected from soil and leaf litter along with crane fly larvae from central California (Merced).

This meeting saw the election of the Society's Executive Council for two-year terms. Dr. Susan King was reelected President, along with Dr. Jamie Cromartie (Vice President), Dr. Faith Kuehn (Treasurer), Mr. Greg Cowper (Corresponding Secretary), and Dr. Charles Bartlett (Recording Secretary). Both Kuehn and Cowper are new additions to Council. There were 32 members and visitors at the meeting.

Jon Gelhaus, (Past) Corresponding Secretary of
The American Entomological Society
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Buthid scorpion in Dominican amber. Approximately 20 million years old.

Photo by Patrick R. Craig (Monte Rio, California, U.S.A)

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SEASONAL FLIGHT ACTIVITY OF STORED-PRODUCT MOTHS (LEPIDOPTERA: PYRALIDAE, GELECHIIDAE) IN SOUTH CAROLINA, U.S.A.¹

Richard T. Arbogast²

ABSTRACT: There is little information available on the flight activity of stored-product moths outside farm bins during grain storage and inside empty bins after removal of the grain. The flight activity of three species – *Plodia interpunctella* (Hübner), *Cadra cautella* (Walker), and *Sitotroga cerealella* (Olivier) – was monitored for two storage seasons on two farms in southern South Carolina by means of pheromone-baited traps. *Plodia interpunctella* accounted for most captures by far, followed by *C. cautella* and *S. cerealella*. Various moths other than stored-product species were also captured. Moth activity in general was highest in the spring and fall, lowest in the winter. All of the storage species showed at least some activity throughout the year, but trap catch of *P. interpunctella* was concentrated in the spring and that of *C. cautella* in the summer and fall. *Sitotroga cerealella* was taken in relatively low numbers, especially during the second storage season. During the first storage season, most captures of *S. cerealella* occurred in spring and summer, but we had no fall data. Of the few captured during the second storage season, most were captured in the fall. *Plodia interpunctella* was abundant in empty storage bins during the brief period between crops in late summer, but *C. cautella* and *S. cerealella* were found in smaller numbers. Air temperature clearly had an impact on flight activity, but seasonal affects other than the direct impact of temperature, such as the influence of temperature on population growth and decline, must also influence flight activity.

KEY WORDS: seasonal flight activity, stored-product moths, Lepidoptera, *Plodia interpunctella*, *Cadra cautella*, Pyralidae, *Sitotroga cerealella*, Gelechiidae, stored grain, South Carolina, U.S.A.

The Indian meal moth, *Plodia interpunctella* (Hübner), the almond moth, *Cadra cautella* (Walker), and the Angoumois grain moth, *Sitotroga cerealella* (Olivier), are cosmopolitan pests of stored grain. All three species are commonly encountered in shelled corn stored on farms in South Carolina and are often abundant at the surface of the grain bulk, and in the headspace of the storage bins (Horton 1982, Arbogast and Throne 1997, Arbogast and Chini 2005). The first two species (Pyralidae) attack a wide range of plant material in addition to cereal grains and their products. Although they cannot feed on intact kernels, grain harvested by combine contains enough broken kernels and fine material to support population growth. The Angoumois grain moth (Gelechiidae) deposits its eggs on the outside of grain kernels, and newly hatched larvae burrow into the kernels or enter through cracks in the pericarp. Development is completed within a kernel, and the adult emerges by pushing out a weakly fastened flap of pericarp prepared by the larva before pupation.

Arbogast and Chini (2005) reported the seasonal abundance of *P. interpunctella* and *C. cautella* on farm-stored corn in South Carolina. Throne and Cline (1989, 1991, 1994) reported the seasonal flight activity and abundance of the maize weevil, *Sitophilus zeamais* Motschulsky, the rice weevil, *Sitophilus*

¹ Received on January 25, 2005. Accepted on March 21, 2005.

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oryzae (L.), and other stored-product beetles on three South Carolina farms, including the two farms used in the present study, but they did not determine the flight activity of moths. The purpose of the present study was to estimate flight activity of *P. interpunctella* and *C. cautella* outside grain bins during the storage period, as well as inside empty bins during the short period between unloading one crop and loading the next. However, *S. cerealella*, and various moths other than stored-product species were also captured in the traps, and the numbers captured were recorded.

METHODS

Storage sites. The storage sites (Fig. 1), located on farms in Barnwell and Bamberg Counties, were separated by a distance of about 35 km. There were six corrugated steel bins of various sizes at the Barnwell site; all were 7.3 m in diameter, but they differed in height. Bins 1 and 2, our study bins, were 5.7 m high at the eaves and were filled with corn during late August and early September 1990, leaving a headspace of about 2.7 m at the center. They were emptied during July 1991 and again filled with corn in early September. We also used these bins during the 1990-91 (bin 2) and 1991-92 (bin 1) storage seasons in our study of *P. interpunctella* and *C. cautella* infesting stored corn (Arbogast and Chini 2005). Bins 3 and 4 were smaller, but their height was not determined. Bin 3 contained a small quantity of wheat and bin 4 a small quantity of oats. Bins 5 and 6, which were 6.3 m high, were empty. The Bamberg site had five bins, each about 5.5 m in diameter x 5.5 m high, and three smaller bins (Fig. 1). Bins 1 and 2 were empty initially but were filled with wheat following the harvest in June 1991. Bins 3-5 contained corn harvested in late summer and early fall 1990. Bin 5, our study bin, was filled by early September 1990, leaving a headspace of about 2.0 meters. It was emptied in early July 1991 and filled again in late August. This bin was always used for corn storage and was employed in our study of *P. interpunctella* and *C. cautella* populations (September 1990 - June 1993) (Arbogast and Chini 2005). The large (numbered) bins at both sites were equipped with perforated false floors and aeration fans so that outside air could be blown under the floor and forced upward through the grain bulk to maintain uniform grain temperature and reduce the risk of damage or spoilage.

First storage season. The first storage season extended from September 1990, when the bins were filled, to July 1991, when they were emptied. The original plan was to monitor moth populations inside the bins. Outside trapping was not added to the protocol until late in November. At that time, four pheromone-baited sticky traps (Pherocon 1C Traps with IMM + 4 lures) (Trécé, Inc., Adair, OK) were positioned around the bins on each farm (Fig. 1). The traps at the Barnwell site were located about 6 m (1), 90 m (2), 46 m (3), and 5 m (4) from bin 2. The traps at the Bamberg site were located about 56 m (1), 39 m (2), 53 m (3), and 27 m (4) from bin 5. All were hung from supporting steel poles at a height of about 1.5 m. In July, after the bins had been emptied, one trap was placed in each of two bins (1 and 2) on the Barnwell farm and one in bin 5 on the Bamberg farm. These were suspended from the center of the bin at a height of about 1.5 m above the floor. The number of *P. interpunctella*, *C. cautella*, *S. cerealella*, and other moths (mostly unidentified) in each trap was determined at weekly intervals. Traps were replaced when they became dirty or were damaged, and lures were replaced at least every six weeks.

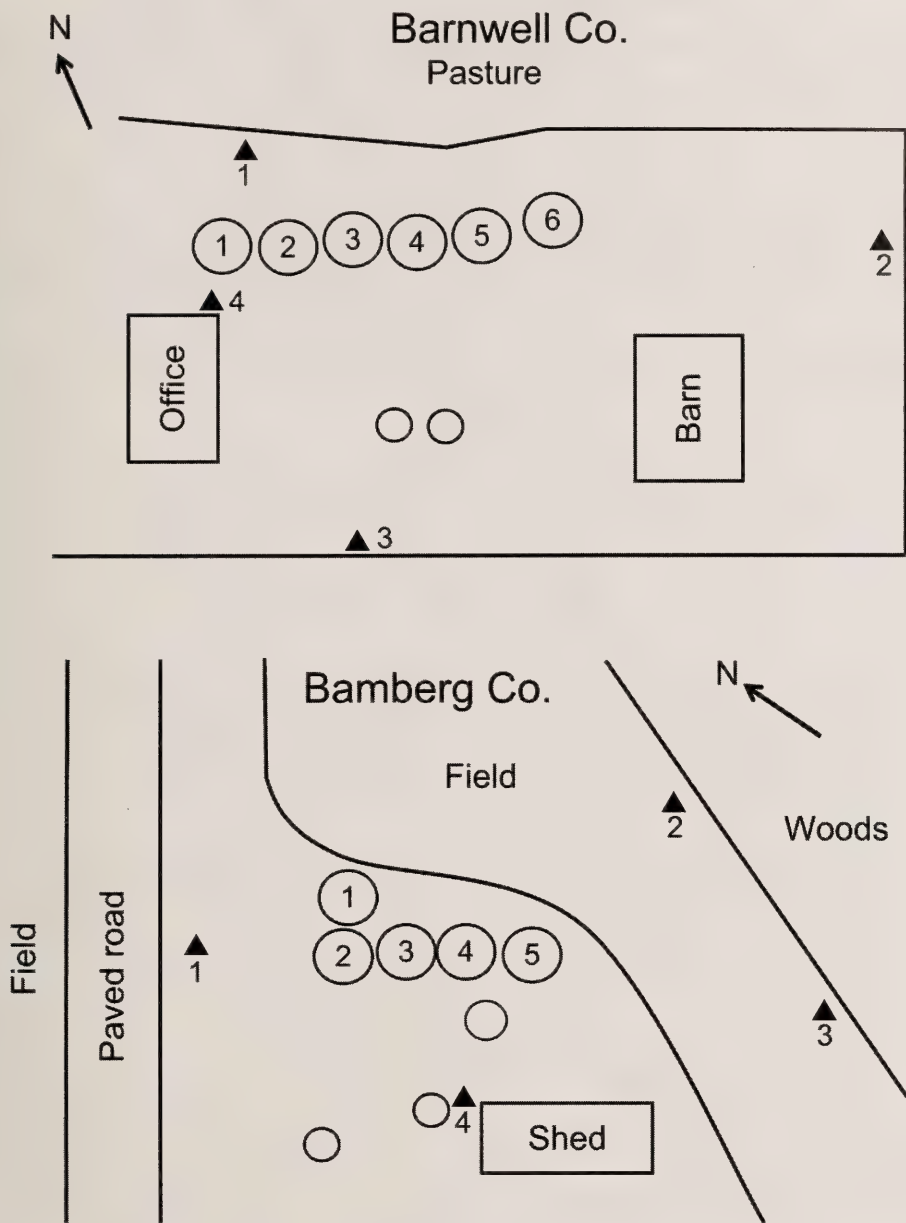


Fig. 1. Layout of grain storage sites in Barnwell and Bamberg Counties, South Carolina (scale is approximate). Black triangles represent trap locations.

Second storage season. The second storage season extended from August 1991 to May 1992 (Bamberg) or from September 1991 to April 1992 (Barnwell). For this season, we changed to plastic funnel traps (Universal Moth Trap or UNI-TRAP, International Pheromone Systems Ltd., Ellesmere Port, Cheshire, UK) – mainly to eliminate the problem of identifying moths trapped on a sticky surface. The funnel traps were baited with IMM + 4 lures and contained toxicant strips (10 percent DDVP in PVC) (Hercon Vaportape II, Hercon Environmental, Emigsville, PA) for rapid knock down. The traps were deployed as before, except that a fifth trap was placed about 1 m from each study bin. Moths were removed, identified, and counted at weekly intervals. The lures were replaced at least every

six weeks, and the toxicant strips were replaced monthly. Trapping was terminated when the bins were emptied. Because of a change in trap type, the data for the second storage season were analyzed separately from those for the first.

Temperature. Daily maximum temperatures were obtained from the climatological records of NOAA Coop Stations (NOAA 1990-1992). One of these (Blackville 5W) was about 6 km southwest of the Barnwell site and the other (Bamberg) was about 18 km northwest of the Bamberg site. The highest daily maximum and lowest daily minimum for each week were plotted against time (Fig. 2).

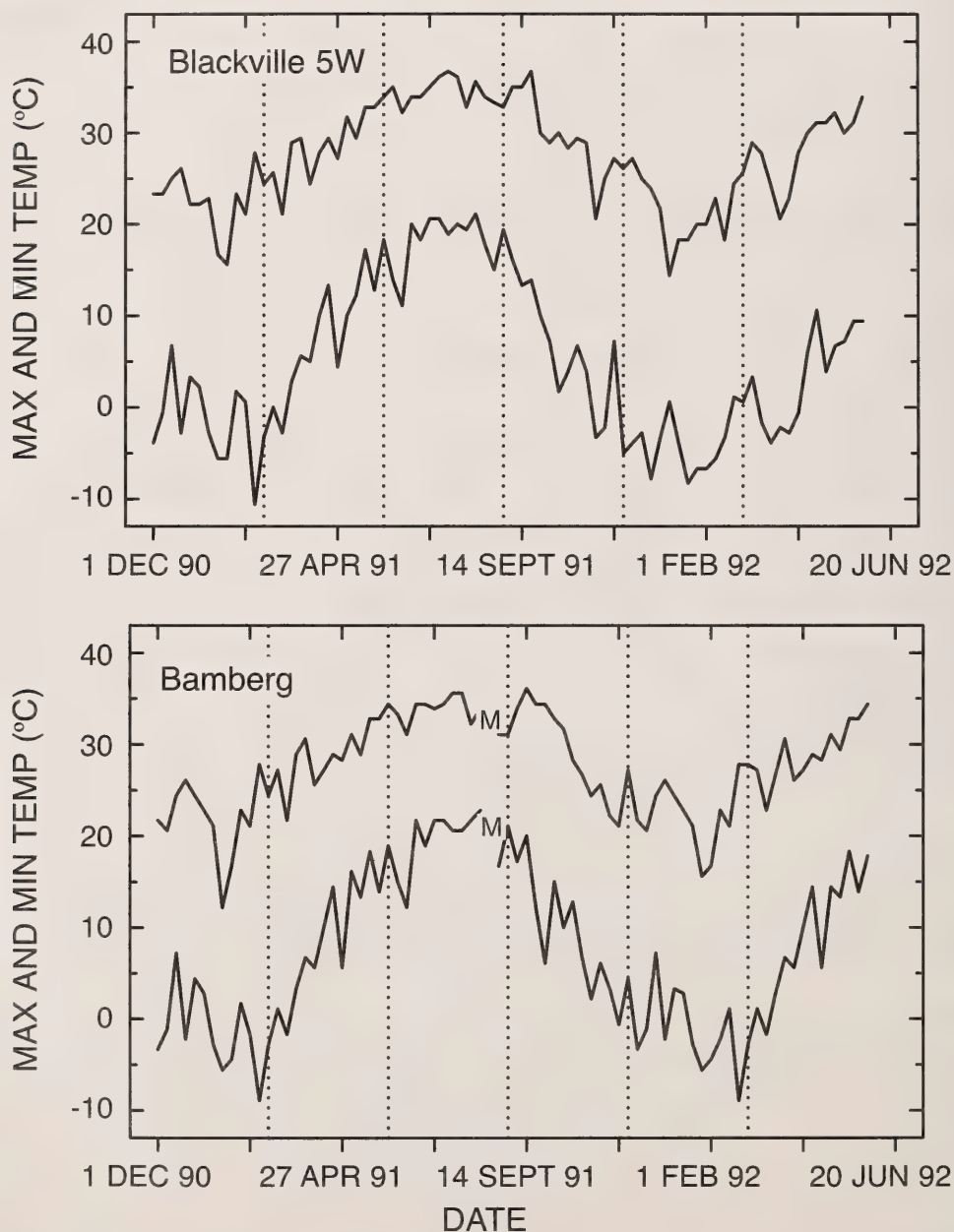


Fig. 2. Weekly maximum and minimum temperatures determined from daily maxima and minima recorded at NOAA Coop weather stations in Barnwell and Bamberg Counties. The vertical dotted lines divide the storage period into seasons (winter, spring, summer, and fall). M indicates missing data.

RESULTS AND DISCUSSION

The pheromone lure used in the traps is known to attract males of five stored-product pyralid species, including *P. interpunctella* and *C. cautella*. However, *S. cerealella* and a variety of moths (mostly unidentified) other than storage species were also trapped. These probably encountered the traps by chance, but we cannot rule out the possibility of attraction.

First storage season. The traps outside the bins at the Barnwell site captured a total of 2,477 *P. interpunctella*, 199 *C. cautella*, 71 *S. cerealella*, 16 *Hypena scabra* (Fabricius) (Noctuidae), and 1,135 moths of unidentified species over a period of 39 weeks. Traps at the Bamberg site captured 501 *P. interpunctella*, 21 *C. cautella*, 25 *S. cerealella*, 2 *H. scabra*, and 352 unidentified species during the same period.

Hypena scabra, the green cloverworm, overwinters as pupae, or as adults that shelter in barns and other protected places (Metcalf et al. 1951), and we occasionally found the adults sheltering in grain bins in South Carolina during the winter (November and December). The moths were very active and often flew out the bin hatch as soon as it was opened.

The highest level of moth activity (all species combined), determined by trap catch, occurred in the spring (late March through early June) (Table 1) with peaks of *P. interpunctella* activity in late March to early April at Bamberg and in mid-April at Barnwell (Fig. 3). Flight activity continued through the summer, but at a lower level, and there was little activity during the winter, with the exception of *H. scabra*. Most *H. scabra* were captured during the winter and early spring (Table 1) when the adults were overwintering in grain bins. Only one was captured in the summer, during the week of June 9 at Barnwell. Most *C. cautella* were captured during the summer, and captures of *S. cerealella* were about equally distributed between spring and summer (Table 1).

Plodia interpunctella was abundant in the empty bins at both sites, but *C. cautella* and *S. cerealella* were found in smaller numbers, and no *S. cerealella* were found at Bamberg. These moths were presumably breeding on grain debris that had accumulated under the aeration floor, or that had been spilled outside the bin. The Barnwell bins were empty for 6-7 weeks, but traps were in place for only 5 weeks (31 July - 5 September). During this period, 141 *P. interpunctella*, 48 *C. cautella*, 2 *S. cerealella*, and 27 unidentified moths were captured in bin 1 and 387 *P. interpunctella*, 32 *C. cautella*, 4 *S. cerealella*, and 19 unidentified moths in bin 2. The Bamberg bin was empty for five weeks (17 July - 22 August) during which 230 *P. interpunctella* and 2 *C. cautella* were captured.

Weekly capture rates (mean number of moths captured per week) were lower overall at Bamberg than at Barnwell and varied on both farms with trap position (Table 2). As might be expected, capture rate was influenced by the proximity of a trap to the bins. Traps 1 and 4, which were closest to the bins at both sites, captured more storage moths than traps 2 and 3. The capture rates of traps 2 and 3 did not differ from one another on either farm, but trap 4 had a higher capture rate than 1 at both sites, even though 4 was slightly closer to the bins. The difference in capture rates of *P. interpunctella* between farms reflects the difference

in population levels inside the bins as estimated by trapping of mature larvae (Arbogast and Chini 2005). However, population levels of *C. cautella* larvae inside the bins were higher at Bamberg than at Barnwell while capture rates outside were lower.

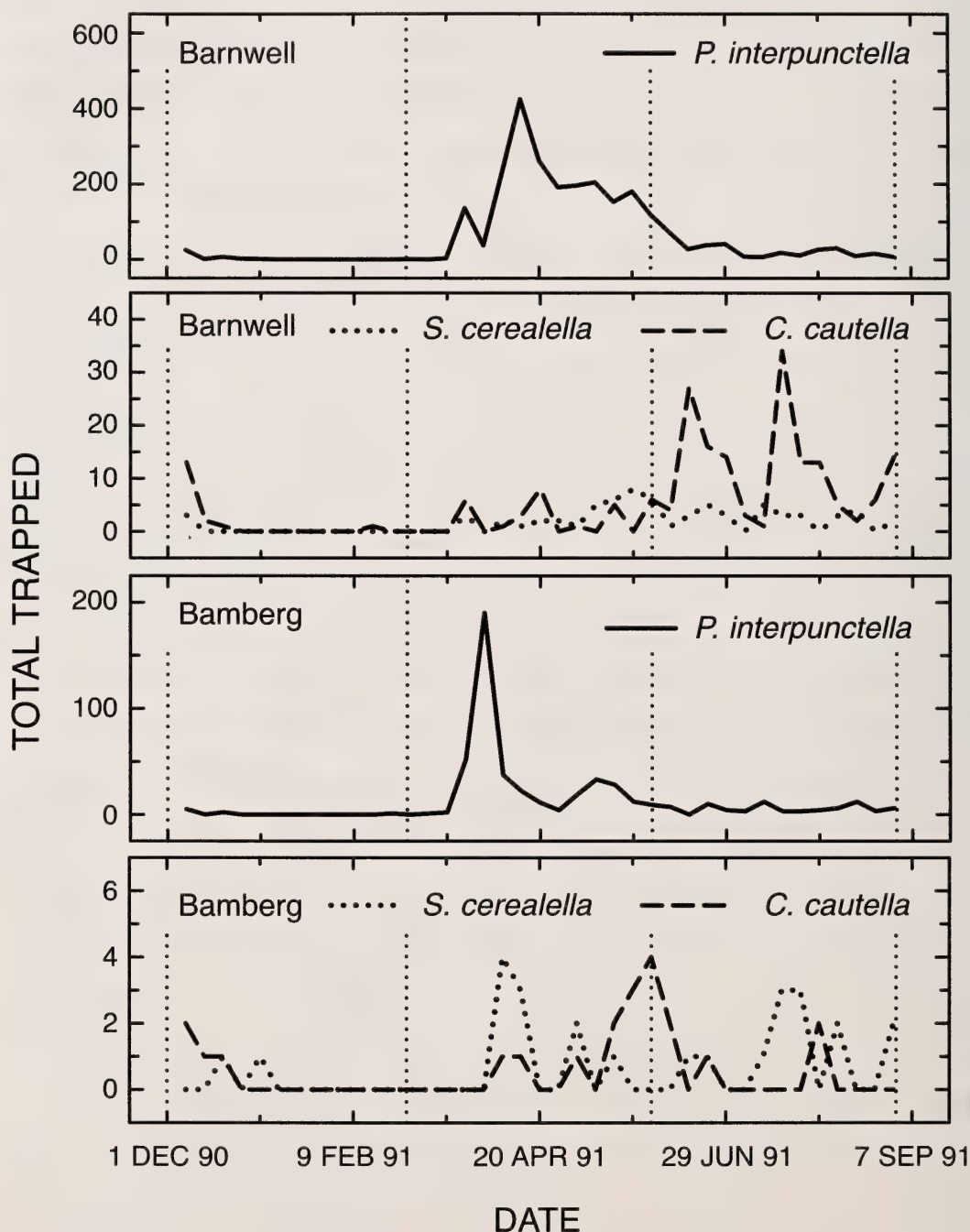


Fig. 3. Weekly variation in total trap catch of *P. interpunctella*, *C. cautella* and *S. cerealella* at grain storage sites on two South Carolina farms during the 1990-1991 storage season. No trapping was done during the first 3 months of storage. The traps used were Trécé Pherocon 1C traps with IMM + 4 pheromone lures. The vertical dotted lines divide the storage period into three seasons (winter, spring, and summer).

Second storage season. Total trap catch for the two farms was much lower during the second storage season than during the first (Table 1). This may indicate that fewer moths were flying, but because different trap types were used, it could also indicate a difference in trap efficiency. At Barnwell, 264 *P. interpunctella*, 425 *C. cautella*, 10 *S. cerealella*, and 7 moths of unidentified species were captured over a period of 30 weeks. At Bamberg, 57 *P. interpunctella*, 8 *C. cautella*, and 3 *S. cerealella* were captured over a period of 32 weeks. No *H. scabra* were captured at either site. Most of the moths (77 percent at Barnwell and 66 percent at Bamberg) were captured by the traps located 1 m from the bins.

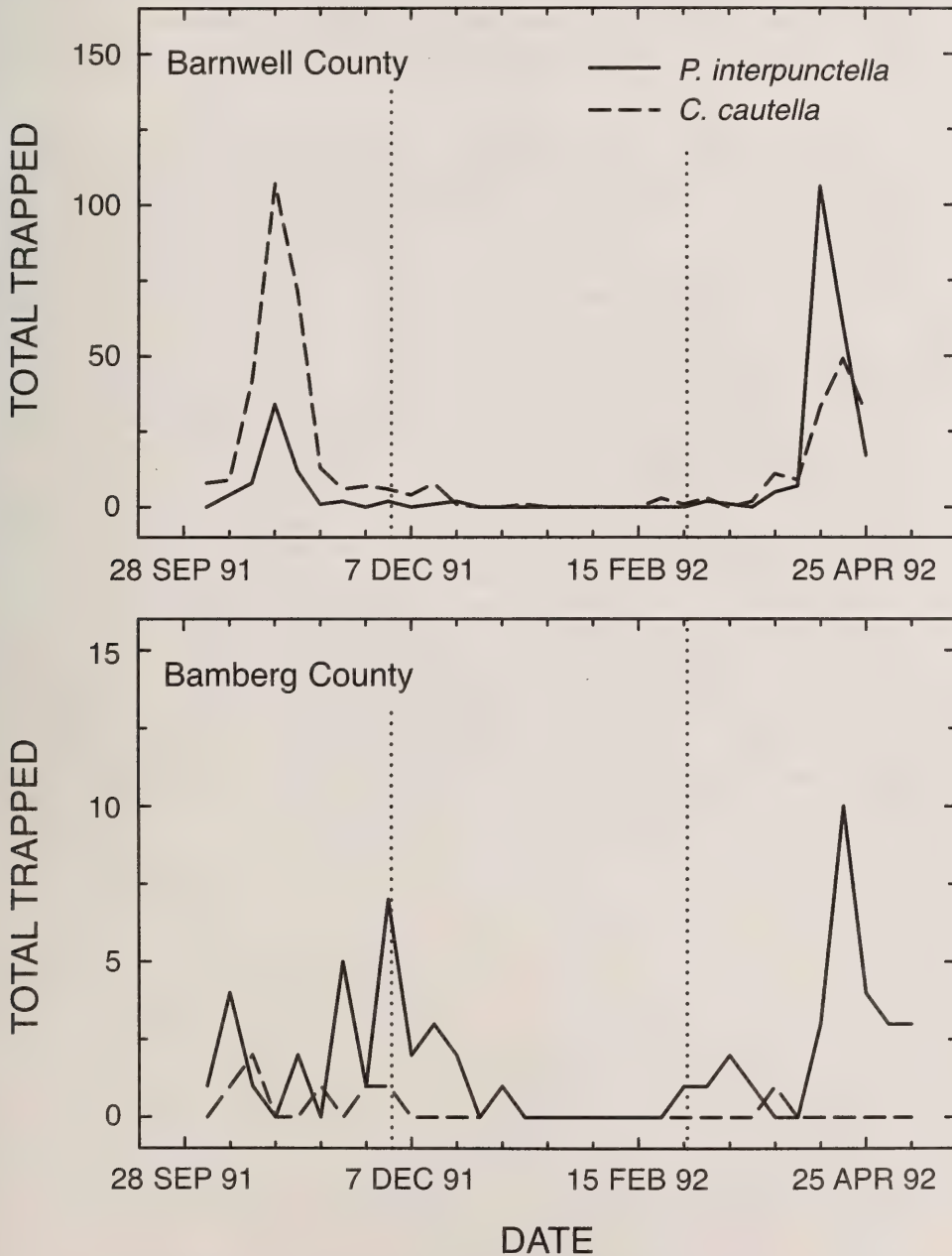


Fig. 4. Weekly variation in total trap catch of *P. interpunctella* and *C. cautella* at grain storage sites on two South Carolina farms during the 1991-1992 storage season. The traps used were Universal Moth Traps (UNITRAP) with Trécé IMM + 4 pheromone lures. The vertical dotted lines divide the storage period into three seasons (fall, winter, and spring).

Most flight activity occurred during spring and fall (Table 1), but there was some activity during December and late February as well (Fig. 4). At Barnwell, trap catch of both *P. interpunctella* and *C. cautella* peaked during late October and again in mid-April. *Cadra cautella* was the more abundant of the two species in the fall; *P. interpunctella* was the more abundant in the spring. Although the graphs of trap catch at Bamberg represent very few moths, they, nevertheless, show a clear seasonal pattern much like that at Barnwell (Figs. 3-4). As at Barnwell, *P. interpunctella* showed a distinct peak in mid-April, but both species showed a series of subequal peaks during the fall and early winter, possibly as a consequence of sparse and spotty trap catch. The few *S. cerealella* recorded at the two sites, were captured during the fall and spring, mostly during the fall (Table 1).

Effect of Temperature. Air temperature (Fig. 2) clearly had an impact on flight activity, but it isn't possible on the basis of our data to estimate temperature thresholds for flight. During the winter, when flight activity was lowest (Figs. 3-4), the maximum temperature for most weeks (both weather stations) was $< 25^{\circ}\text{C}$ and the minimum was almost always $< 5^{\circ}\text{C}$. In spring, the weekly maximum was $> 25^{\circ}\text{C}$ for most weeks and $> 30^{\circ}\text{C}$ for some. During the summer, the weekly maximum was always $> 30^{\circ}\text{C}$ and occasionally $> 35^{\circ}\text{C}$. Seasonal affects other than the direct impact of temperature, such as the effect of temperature on population growth and decline (Arbogast and Chini 2005), must also influence flight activity. For example, all three species of storage moths were sometimes captured during weeks when the weekly maximum temperature was as low as 21.7°C , but sometimes none were captured when the weekly maximum was $> 30^{\circ}\text{C}$. Throne and Cline (1989) reported that their flight traps captured many species of insects throughout the year around grain bins in South Carolina, but that *S. zeamais* and *S. oryzae* did not fly when the maximum temperature was less than 23.3 to 26.1°C . They pointed out that these temperatures were probably not the lower thresholds for flight, because a minimum period above threshold is probably required to enable flight.

Table 1. Flight activity of moths around grain storages in South Carolina, U.S.A. (winter 1990 to summer 1991 and fall 1991 to spring 1992): total numbers trapped on two farms (N) and seasonal distribution of captures (%).

Species	N	Fall	Winter	Spring	Summer
Winter 1990 – Summer 1991 ¹					
<i>P. interpunctella</i>	2,978	—	1.5	85.7	12.9
<i>C. cautella</i>	220	—	9.6	19.1	71.4
<i>S. cerealella</i>	96	—	5.2	47.9	46.9
<i>H. scabra</i>	18	—	77.8	16.7	5.6
Unidentified	1,487	—	0.1	76.3	23.6
All	4,799	—	1.8	78.7	19.5
Fall 1991 – Spring 1992 ²					
<i>P. interpunctella</i>	321	23.4	6.5	70.1	—
<i>C. cautella</i>	433	61.9	6.0	32.1	—
<i>S. cerealella</i>	13	69.2	7.7	23.1	—
Unidentified	7	14.3	14.3	71.4	—
All	774	45.6	6.3	48.1	—

¹ Winter: 28 November – 6 March. Spring: 6 March – 5 June. Summer: 5 June – 4 September. Pherocon 1C traps.

² Fall: 2 October – 27 November. Winter: 27 November – 26 February. Spring: 26 February – 13 May. UNITRAP.

Table 2. Weekly capture rates of three stored-product moths in the vicinity of grain storage bins on two South Carolina farms, November 28, 1990 - September 4, 1991.

Farms / trap no.	Mean ¹ number of moths captured per week $\pm$ SE		
	<i>P. interpunctella</i>	<i>C. cautella</i>	<i>S. cerealella</i>
<i>Barnwell County</i>			
1	18.0 $\pm$ 5.8	0.6 $\pm$ 0.2	0.6 $\pm$ 0.2
2	1.0 $\pm$ 0.3	0.2 $\pm$ 0.1	0.0 $\pm$ 0.0
3	0.8 $\pm$ 0.2	0.4 $\pm$ 0.1	0.1 $\pm$ 0.1
4	43.7 $\pm$ 10.0	4.0 $\pm$ 1.1	1.1 $\pm$ 0.3
Total	63.5 $\pm$ 15.6	5.1 $\pm$ 1.2	1.8 $\pm$ 0.3
<i>Bamberg County</i>			
1	2.7 $\pm$ 1.6	0.1 $\pm$ 0.1	0.2 $\pm$ 0.1
2	0.6 $\pm$ 0.2	0.0 $\pm$ 0.0	0.1 $\pm$ 0.0
3	0.6 $\pm$ 0.2	0.0 $\pm$ 0.0	0.1 $\pm$ 0.1
4	9.0 $\pm$ 3.2	0.4 $\pm$ 0.1	0.3 $\pm$ 0.1
Total	12.8 $\pm$ 5.0	0.5 $\forall$ 0.2	0.6 $\pm$ 0.2

¹ Means based on 39 weeks.

CONCLUSION

Trap catch data for the two storage seasons show that moth activity was highest in the spring and fall, lowest in the winter. Only *H. scabra* was most active during the winter. All of the storage species showed at least some activity throughout the year, but trap catch of *P. interpunctella* was concentrated in the spring and that of *C. cautella* in the summer and fall. Although *S. cerealella* was taken in relatively low numbers, especially during the second storage season, it was clear that some flight activity occurred throughout the year, mostly during spring, summer, and fall. The seasonal pattern of flight activity exhibited by *P. interpunctella* in South Carolina was much like that observed in a culled-fig warehouse at Fresno, California, which has a temperature regime similar to that of the South Carolina sites (Johnson et al. 2000). The spring peak was attributed to emergence from (larval) diapause and the fall peak to the arrival of infested figs during late summer. Lack of activity during the winter was attributed to onset of diapause, low activity during the summer to high temperatures and low fig volume. Populations of *P. interpunctella* and *C. cautella* inside the South Carolina bins – based on numbers of mature wandering larvae that entered coils of corrugated paper for pupation – increased during the fall to maximum levels in late November to early December and then began to decline, reaching barely detectable levels by June (Arbogast and Chini 2005). The spring and fall peaks of flight activity could include both moths emigrating from the bins and moths from outside sources. The timing of these peaks, as affected by adult emergence and emigration from the bins, can be explained by acceleration and deceleration of larval and pupal development in response to seasonal changes in grain and headspace temperatures (Arbogast and Chini 2005). Although the larvae may be quiescent when temperatures are low, there is no evidence of a larval diapause in the populations studied.

The pattern of flight activity exhibited by *P. interpunctella* and the other moths in South Carolina can be expected to differ markedly from those observed in cooler climates. For example, trap catch of male *P. interpunctella* inside and outside a flour mill in Kansas showed that outside flight activity increased between July and September and then declined to zero by November; flight activity inside the mill tended to follow the same seasonal pattern as that for insects outside the mill (Campbell and Arbogast 2004).

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A NEW SPECIES OF *ISOPHYA* BRUNNER VON WATTENWYL (ORTHOPTERA: TETTIGONIIDAE: PHANEROPTERINAE) FROM TURKEY¹

Mustafa Ünal²

ABSTRACT: A new species of *Isophya* Brunner von Wattenwyl, *I. karadenizensis* sp.n. is described from eastern part of the Karadeniz Region of Turkey. A key to *pyrenaea* species group of the genus is provided. Illustrations, distributional map and a check list of the known *Isophya* species from the Region are added.

KEY WORDS: taxonomy, Orthoptera, Phaneropterinae, *Isophya*, Turkey, Karadeniz region, new species, check list

Kenneth M. Guichard, who was an excellent collector of insects (1914-2002) and hymenopterist David H. Harvey, made three major collecting expeditions to Turkey for the Natural History Museum London (BMNH). The first was made by Guichard in 1959 and the last two were made both researchers in 1960 and 1962. In these expeditions, materials in Hymenoptera, Orthoptera, Diptera, Lepidoptera (Rhopalocera), Hemiptera, Homoptera, Coleoptera, and Odonata were collected from various parts of Turkey (Guichard and Harvey, 1967; pers. commun. Judith Marshall). Most of the specimens of Orthoptera collected by Guichard and Harvey were evaluated by the famous Turkish Orthopterist Tevfik Karabağ (1911-2003). He described five species in the genera *Poecilimon* Fisher, *Pholidoptera* Wesmäl and *Parapholidoptera* Maran among that material (Karabağ, 1961, 1964, 1975). After him, two *Glyptothymis* Bey-Bienko (Cejchan, 1964; 1965) and two *Parapholidoptera* Maran (Stolyarov, 1984; Ciplak, 2000) were described from that material deposited in the Natural History Museum London.

During a recent study in the Natural History Museum London, the author recognized some specimens collected by Guichard and Harvey, as belonging to an undescribed species of the genus *Isophya* Brunner von Wattenwyl. The specimens were collected at high elevations in the Soğanlı Mountain, eastern part of Karadeniz, one of the geographical regions of Turkey (Fig. 9).

Isophya is a widespread genus in Turkey and it is also from southern and south-eastern Europe, Caucasia, Middle East, Middle Asia (Ünal, 2004) and it prefers mostly cool, humid climates and mesic vegetation. *Isophya* can be frequently found from low elevations (to 1000 m) in the second half of spring and early summer (April, May and June) and, at some high elevations (1500-2000 m), in late summer (July and August) of the geographical regions of the Aegean, Mediterranean, Middle Anatolia, a part of east Anatolia and southeast Anatolia which

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have mostly xeric vegetation and high temperatures. A part of the Marmara and especially the Black Sea (Karadeniz) regions have cool and humid climate and mesic vegetation throughout the summer and the beginning of autumn (September). Therefore, it is possible to find many species of *Isophya* during this period in the Karadeniz region (Table 1) (Miram, 1938; Ramme, 1951; Bey-Bienko, 1954; Karabağ, 1958, 1962; Maran, 1958; Ünal, 2003b, 2004; Sevgili, 2004).

This paper contains the description of *Isophya karadenizensis*, a new species from the Karadeniz Region of Turkey, with illustrations (Figs. 1-8) and a distribution map (Fig. 9). A check list of the species of *Isophya* known from the Karadeniz Region (Table 1) and a tabular key to related congeners are included (Table 2).

Table 1. Check list of the *Isophya* Brunner von Wattenwyl species known from the Karadeniz Region of Turkey.

- | | |
|---|---|
| 1. <i>I. acuminata</i> Brunner, 1878 | 10. <i>I. pavelii</i> Brunner, 1878 |
| 2. <i>I. amplipennis</i> Brunner, 1878 | 11. <i>I. rectipennis</i> Brunner, 1878 |
| 3. <i>I. autumnalis</i> Karabağ, 1962 | 12. <i>I. redtenbacheri</i> Adelung, 1907 |
| 4. <i>I. bicarinata</i> Karabağ, 1957
(unpubl. data) | 13. <i>I. reticulata</i> Ramme, 1951 |
| 5. <i>I. ilkazi</i> Ramme, 1951 | 14. <i>I. rizeensis</i> Sevgili, 2004 |
| 6. <i>I. karadenizensis</i> sp. n.
(this paper) | 15. <i>I. schneideri</i> Brunner, 1878 |
| 7. <i>I. nervosa</i> Ramme, 1951 | 16. <i>I. staneki</i> Maran, 1958 |
| 8. <i>I. obenbergeri</i> Maran, 1958 | 17. <i>I. stenocauda</i> Ramme, 1951 |
| 9. <i>I. obtusidens</i> Ramme, 1951 | 18. <i>I. sureyai</i> Ramme, 1951 |
| | 19. <i>I. yaraligozi</i> Ünal, 2003 |
| | 20. <i>I. zernovi</i> Miram, 1938 |

Isophya karadenizensis, NEW SPECIES

Figures 1-8

Type Locality: Turkey, Bayburt Province, Soğanly Geçidi, 2000-2500 m, 25 July 1960. Holotype deposited in the Natural History Museum London (BMNH).

Description. Male (holotype): Small size as for the genus. Fastigium of vertex distinctly narrower than half of antennal scape, with a distinct dorsal fossa; ratio of width of fastigium to width of scapus: 1/3, in paratypes 1/4-1/3. Antennal pedicel always broader than fastigium of vertex. Pronotum strongly narrowed anteriorly and widened in posteriorly; prozona constricted with distinct lateral carinae, narrower than head; anterior margin slightly concave, in some males straight; metazona sharply widened and raised, 1.48 times broader than prozona; covers anterior part of tegmina and base of CuP; lateral carina projected like a shoulder; transverse sulcus behind middle of pronotal disc. Tegmina short, as long as pronotum, reaching middle of 2nd abdominal tergite; anterior 1/4 part covered by pronotum; stridulatory file (CuP) long and thin, thinner than third

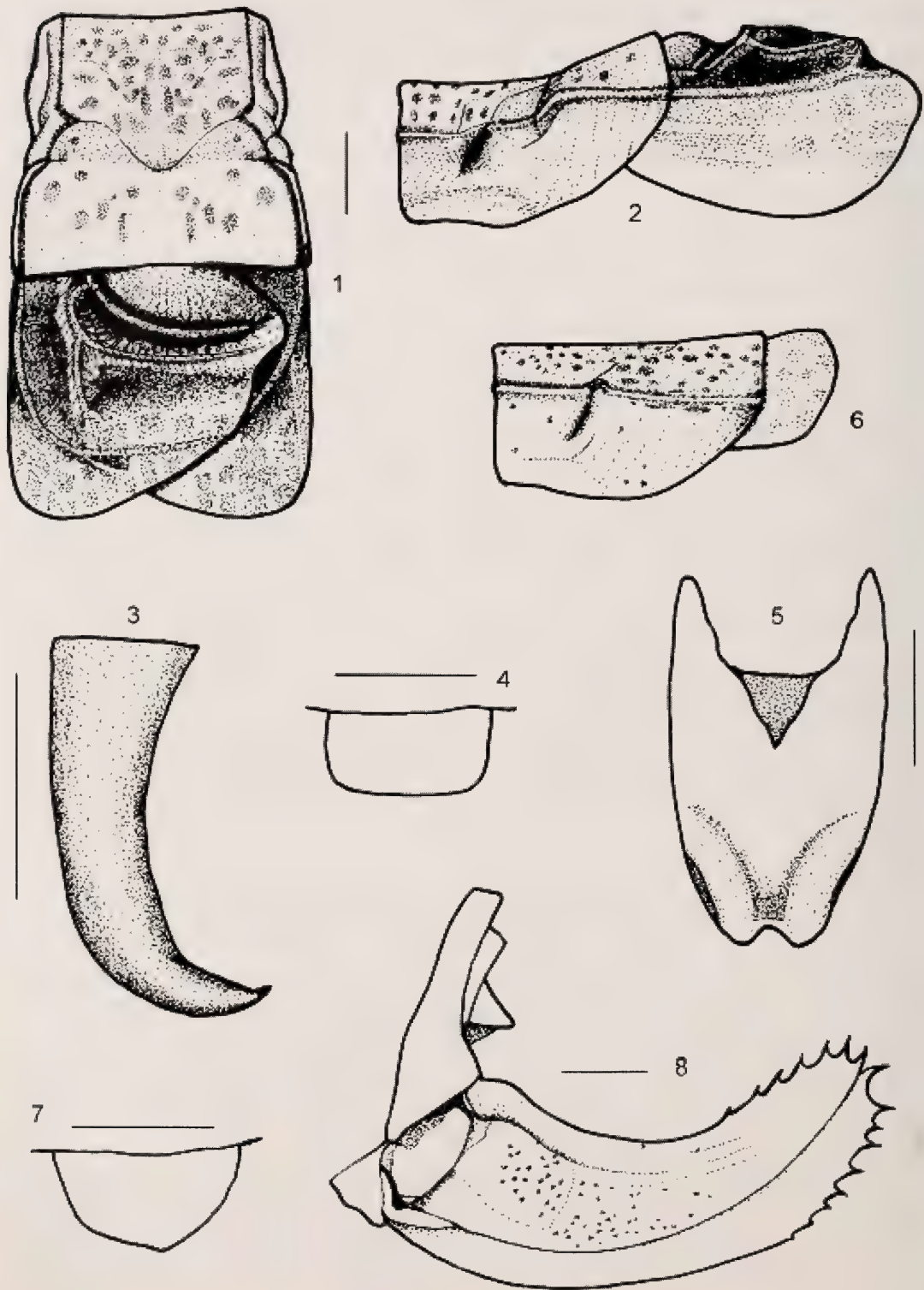
antennal joint, its length $3/4$ of hind margin of pronotum. Hind femur unarmed ventrally. Ratio length of fore tibia / pronotum 1.3. Supraanal plate about rectangular, both hind corners rounded, hind margin straight; 1.5 times longer than wide. Cercus moderately short; basal part somewhat wide, cylindrical and slightly incurved, apical part sharply narrowed and incurved; pointed with a large, curved apical tooth. Subgenital plate 1.8 times longer than wide; with shallow, round incision; its apical lobes with rounded apices; lower face without median carina.

Female: Fastigium of vertex as in male. Pronotum with distinct prozona and metazona; prozona narrow, with distinct lateral carina, anterior margin slightly concave; metazona widened and slightly raised, its lateral carina distinct, posterior margin straight. Tegmina short and wide, broader than hind margin of pronotum, hind margin slightly rounded; only a little surpassing anterior margin of first abdominal tergite; ratio length of tegmina to length of pronotum $1/3.8$. Hind femur unarmed ventrally. Supraanal plate wide at base, 1.3 times broader than long, rounded at apex. Cercus thin slightly curved inwards, longer than supraanal plate, its apex blunt. Subgenital plate broader than long. Ovipositor very short (6 mm); 1.6 times longer than pronotum; upper valve with 7, lower valve with 9 apical teeth; ratio ovipositor to hind femur $1/2$; gonangulum and basal fold of lower valve as in Fig. 8.

Color. Body green, with brown, reddish-brown, black spots and stripes. Dorsal surface of head, pronotum, some femora and all abdominal tergites with dark green, brown, reddish-brown and black spots; antennal scapus and pedicel with small reddish-brown spots, flagellum unicolor as yellowish-brown; head with black longitudinal stripe between eye and pronotum; lateral carina of pronotum light colored, with dark stripe contiguous to carina in metazona. Tegmina partly reddish-brown and green in male, from CuP to anal margin and from subcosta to radius vein of left tegmen reddish-brown, remaining part green; tegmina green in female. All legs yellowish-brown, with dark spots. Abdomen green, with dense dark green, brown or black spots; without any longitudinal band. Male cerci brown or reddish-brown, with black apical tooth. Subgenital plate greenish-yellow with reddish spots. Ovipositor yellowish green, with reddish-brown spots; apices of apical teeth reddish. All sternites greenish-yellow.

Measurements (mm). Length of body: male 17-18.3, female 17; pronotum: male 3.3-3.7, female 3.8; tegmen: male 3.3-3.7, female 1; hind femur: male 11.2-11.9, female 12.1; ovipositor: 6.

Type Material. Turkey, Bayburt Province (formerly the type locality and Bayburt were in Gümüşhane Province), Soğanly Geçidi, 2000-2500 m (7000-7500 ft in the label), 25 July 1960, 13 males (including holotype), 1 female (leg. K. M. Guichard and D. H. Harvey). Eleven males and female are deposited in the Natural History Museum London, two males are in the Entomological Museum of Abant Yzzet Baysal University, Bolu (collection of Mustafa Ünal).



Figures 1-8. *Isophya karadenizensis* n.sp. 1, male pronotum and tegmina; 2, ditto, lateral view; 3, male left cercus; 4, male supra-anal plate; 5, male subgenital plate; 6, female pronotum and tegmen, lateral view; 7, female subgenital plate; 8, ovipositor. Scales 1 mm.

Differential Diagnosis. This new species is recognizable by the structure of pronotum, clearly constricted prozona, widened metazona; the short male tegmina (as long as pronotum); the shape of male cercus; narrowed fastigium of vertex; shape of shortened ovipositor and gonangulum.

Isophya karadenizensis sp. n. is in the *I. pyrenaea* group along with *I. pyrenaea*, *I. zernovi*, *I. bivittata*, *I. schneideri*, *I. altaica* (Bey-Bienko, 1954). The new species is related to *Isophya bivittata* Uvarov known from Caucasia (Bey-Bienko, 1954; Stolyarov, 1997; Systax, 2003) by the narrow fastigium of vertex, structure of pronotum, short male tegmina. But differs from it by the thinner CuP, shape of female tegmina, male cercus and subgenital plate, ratio of the length of ovipositor to the length of pronotum, shorter hind femur, female tegmina and ovipositor, ratio of the length of fore tibia to the length of pronotum, shape of ovipositor and gonangulum. It is similar to *Isophya altaica* Bey-Bienko known from Altai Mountains in Kazakhstan (Bey-Bienko, 1954; Otte et al., 1997) by the structure of pronotum, ratio of the length of pronotum to the length of tegmina in male and coloration. Differs from it in the distinctly narrowed fastigium of vertex, the thinner CuP, the shape of female tegmina, narrowed male tegmina, shape of supraanal plate, ratio of the length of female cerci to the length of supraanal plate; ratio the length of ovipositor to the length of pronotum, shape of shorter ovipositor and in other measurements. It is also near to *Isophya pyrenaea* Serville known from middle Europe (Bey-Bienko, 1954; Harz, 1969; Otte et al., 1997) by the short tegmina (as long as pronotum), the length of female tegmina (1 mm), the shape of hind margin of pronotum. But differs from it by the narrower fastigium of vertex, structure of pronotum, male cerci, subgenital plate, shorter ovipositor and measurements. This new species is near to *I. amplipennis* group (Bey-Bienko, 1954) by the very narrow fastigium of vertex and shortened ovipositor. But the other characteristics, especially the structure of pronotum in both sexes are different from this group.

Etymology. Named after the "Karadeniz" Region, which includes the type locality of this new species (Fig. 9).

Habitat: Soğanlı Mountains (3376 m) are known as a part of the East Black Sea Mountains of Turkey. Soğanlı Geçidi (2330 m) is the high pass on the borders of Bayburt and Trabzon provinces. The north facing slopes just below the pass consist of lush alpine meadows. These hillsides before they merge lower down with dense conifer forest are in places dotted with thick patches of *Vaccinium myrtillus*, a little *Salix* and the white *Rhododendron caucasicum* (Ericaceae) while *Primula auriculata* and *P. kuznetzowii* (Primulaceae) grow beside small bogs and streamlets. The southern slopes lack the typical lush alpine meadows of the northern side and consist in the area of the pass of turf expanses grazed by livestock (Guichard and Harvey, 1967).

Table 2. Comparison of the species of the *pyrenaea* group of *Isophya* Brunner von Wattenwyl.

Species	Fastigium of vertex	Male Pronotum	Male Tegmina	Male cercus	Ovipositor
<i>pyrenaea</i>	slightly narrower than half of scapus	without lateral projecting shoulder; with constriction	same length as pronotum	subapical part thick, gradually incurved; with small apical tooth	8.5-10 mm; twice pronotal length
<i>bivittata</i>	distinctly narrower than half of scapus	with lateral projecting shoulder; with constriction	same length as pronotum	subapical and apical parts thick gradually incurved; with small apical tooth	8-9 mm; 1.7-2 times Postal length
<i>altaica</i>	as broad as half of scapus	with lateral projecting shoulder; with constriction	same length as pronotum	subapical and apical parts thin somewhat sharply incurved; with small apical tooth	8.5-10.2 mm; 2.1-2.3 times pronotal length
<i>zernovi</i>	as broad as half of scapus	without lateral projecting shoulder; without constriction	longer than pronotum somewhat sharply	subapical and apical parts thick pronotal length incurved; with short and wide apical tooth	7-8 mm; 1.5-1.6 times
<i>schneideri</i>	as broad as half of scapus	without lateral projecting shoulder; without constriction	longer than pronotum	subapical and apical parts thin somewhat gradually incurved; with long and distinct apical tooth	7.5-10 mm; 1.4-1.8 times pronotal length
<i>karadenizensis</i>	distinctly narrower than half of scapus	with very distinct lateral projecting shoulder; with constriction	same length as pronotum	subapical and apical parts thin sharply incurved; with long, distinct and curved apical tooth	6 mm; 1.6 times pronotal length

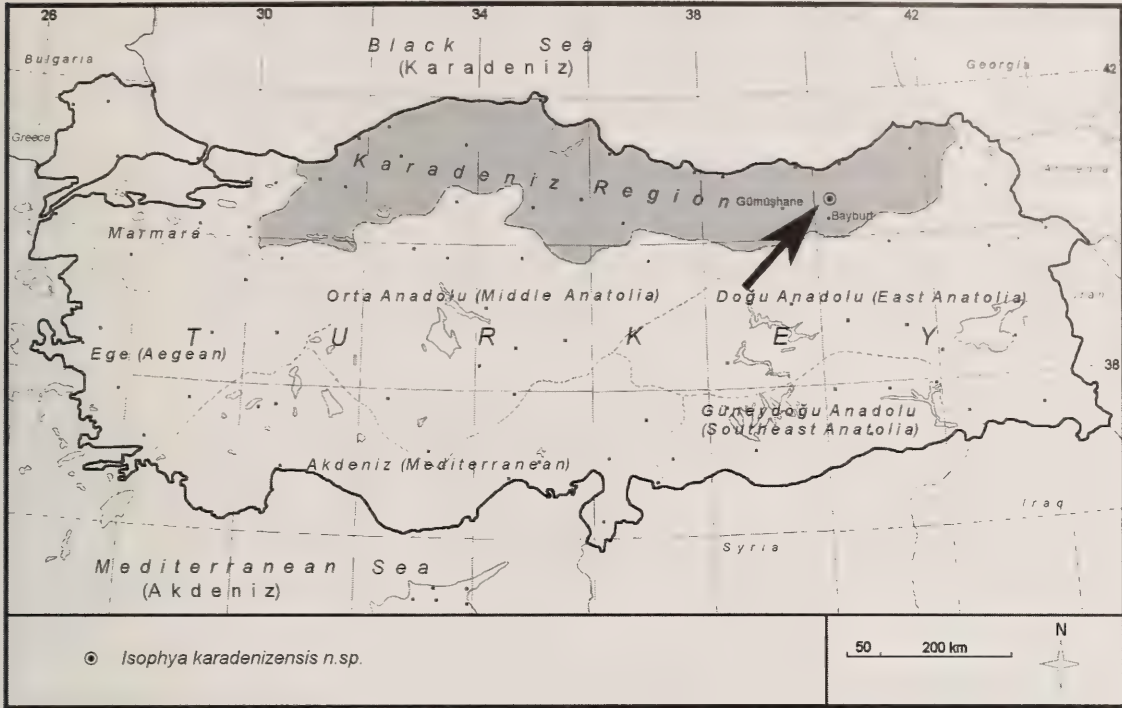


Figure 9. Only known locality of *I. karadenizensis* n.sp. Soğanly Geçidi, NE of Turkey and the geographical regions of Turkey.

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LIFE HISTORY AND LABORATORY REARING OF A WESTERN U.S.A. HEMIPTERAN, *MACROVELIA HORNII* (MACROVELIIDAE)¹

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ABSTRACT: The field life history of *Macrovelia hornii* Uhler was studied periodically from 1990 through early 1994 in central Colorado near Waterton in Douglas County. The bug also was reared in the laboratory from egg to adult. Adults of this apparently univoltine species overwintered and became active in late January. Copulation was noted occasionally from early March to early June. Eggs were found periodically from mid-February to mid-August and always were glued to moss attached to damp or dry rocks. First through third instars were collected first in early May, fourth instars in early June. Higher percentages of later instars were found as the season progressed. The bug was reared in the laboratory on adults of *Drosophila melanogaster* Meigen under a 14L: 10D photoperiod at $18.3 \pm 1.5^\circ\text{C}$. The incubation period averaged 17.4 days. Durations of the four subsequent stadia averaged 8.3, 7.9, 8.5, and 13.1 days, respectively.

KEY WORDS: *Macrovelia hornii*, Hemiptera, Macroveliidae life history, laboratory rearing, univoltinism, western U.S.A.

Macrovelia hornii Uhler ranges from North Dakota south to Nebraska and New Mexico, and west to Oregon and California, and extends into Baja California (Polhemus and Chapman, 1979). Little has been published on its biology, although Anderson (1963) studied the morphology and biology of this insect for his Master's research.

Macrovelia hornii occurs most frequently in damp habitats associated with moving water (McKinstry, 1942; Froeschner, 1988; Zack, 1990), although it also has been collected from the margins of ponds (Anderson, 1963; Zack, 1990). Commonly, individuals are found near permanent springs and streams (McKinstry, 1942; Slater and Baranowski, 1978; Polhemus and Chapman, 1979) and often are associated with moss (McKinstry, 1942; Anderson, 1963; Slater and Baranowski, 1978; Polhemus and Chapman, 1979) and other vegetation (Anderson, 1963; Polhemus and Chapman, 1979). Although they are able to walk on the surface of open water, they apparently prefer protective vegetation (Slater and Baranowski, 1978; Froeschner, 1988). In fact, McKinstry (1942) stated they have apical claws and are "quite helpless upon the surface of the water," an assertion repeated by Usinger (1956). They are carnivores or scavengers, feeding on arthropods, primarily insects (Froeschner, 1988). The species apparently is uni-

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voltine (Anderson, 1963) with adults overwintering (Anderson, 1963; Polhemus and Chapman, 1979).

Polhemus and Chapman (1979) reported on several laboratory observations of this insect. During copulation, the male rode atop the female. She moved from place to place with the male grasping her so firmly that he did not drop off, even when the pair was disturbed. Eggs were laid in moss on exposed rock. They were asymmetrically spindle-shaped, flattened along one side, and glued to the moss. Our paper presents further information on the field life history and laboratory rearing of *M. hornii*.

METHODS

Life History

The study was conducted periodically from 1990 through early 1994 in central Colorado near Waterton in Douglas County. The study area was a permanent set of rheocrenes (= small seepages) on a sloping hillside (Fig. 1) adjacent to the South Platte River, about 300 m downstream from the bridge at Waterton. The area preferred by these insects has many stones interspersed with watercress and grasses growing on wet gravel. This vegetation is lush during midsummer but almost absent during midwinter.

The study began in late January, after adults had become active but before they had begun to reproduce. As this population is small, there was concern with over-collecting. Therefore, samples were taken only at irregular intervals during 1990 (11 samples, 31 January-4 September), 1992 (6 samples, 3 June-13 October), and 1994 (3 samples, 22 March-21 May). Eggs, nymphs, and adults were collected by hand-picking (JTP), preserved in 80 percent ethanol, and examined in the laboratory (JEM) to determine the developmental stages in each sample. Observations also were made during the winter to determine the overwintering stage(s) and sites. Data from the three years were combined to gain a better understanding of the annual life cycle.

Laboratory Rearing

On 5 February 1990, JTP collected 21 adults from the Waterton site and shipped them to JEM's laboratory at Southern Illinois University at Carbondale with a sample of spring water and moss-covered rocks from the insects' habitat. Both were used during laboratory rearing.

The adults (not sexed) were placed in a bowl with a beveled lip (≈ 12.5 cm ID at top, 20 cm ID at widest point, 10.5 cm depth). Moss-covered rocks were placed in the bowl and ≈ 0.5 cm of the spring water (i.e., enough to cover the bottom) was added. The bowl was closed with cheesecloth secured with a rubber band.

Eggs were removed daily and placed on moist filter paper in Petri dishes (≈ 9 cm ID, 4 cm depth). Dechlorinated water was added as needed (every 1-2 days) to keep the filter paper moist.

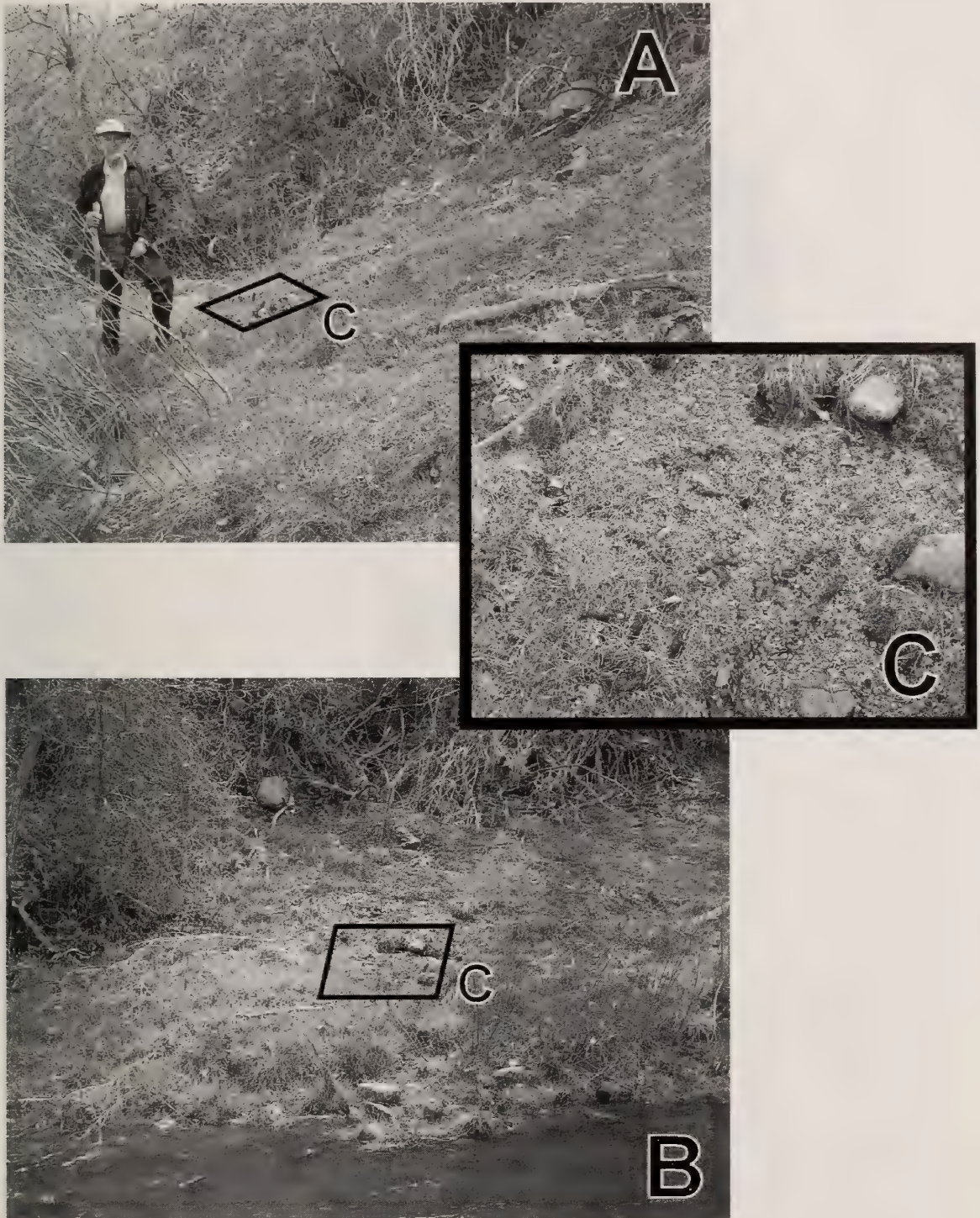


Fig. 1. *Macrovelia hornii* collecting site near Waterton in Douglas County, Colorado. A. Sloping hillside leading to South Platte River (JTP provides scale). B. Slope ending adjacent to South Platte River. C. Close-up (inset from A and B) of slope showing primarily watercress interspersed with boulders and rocks.

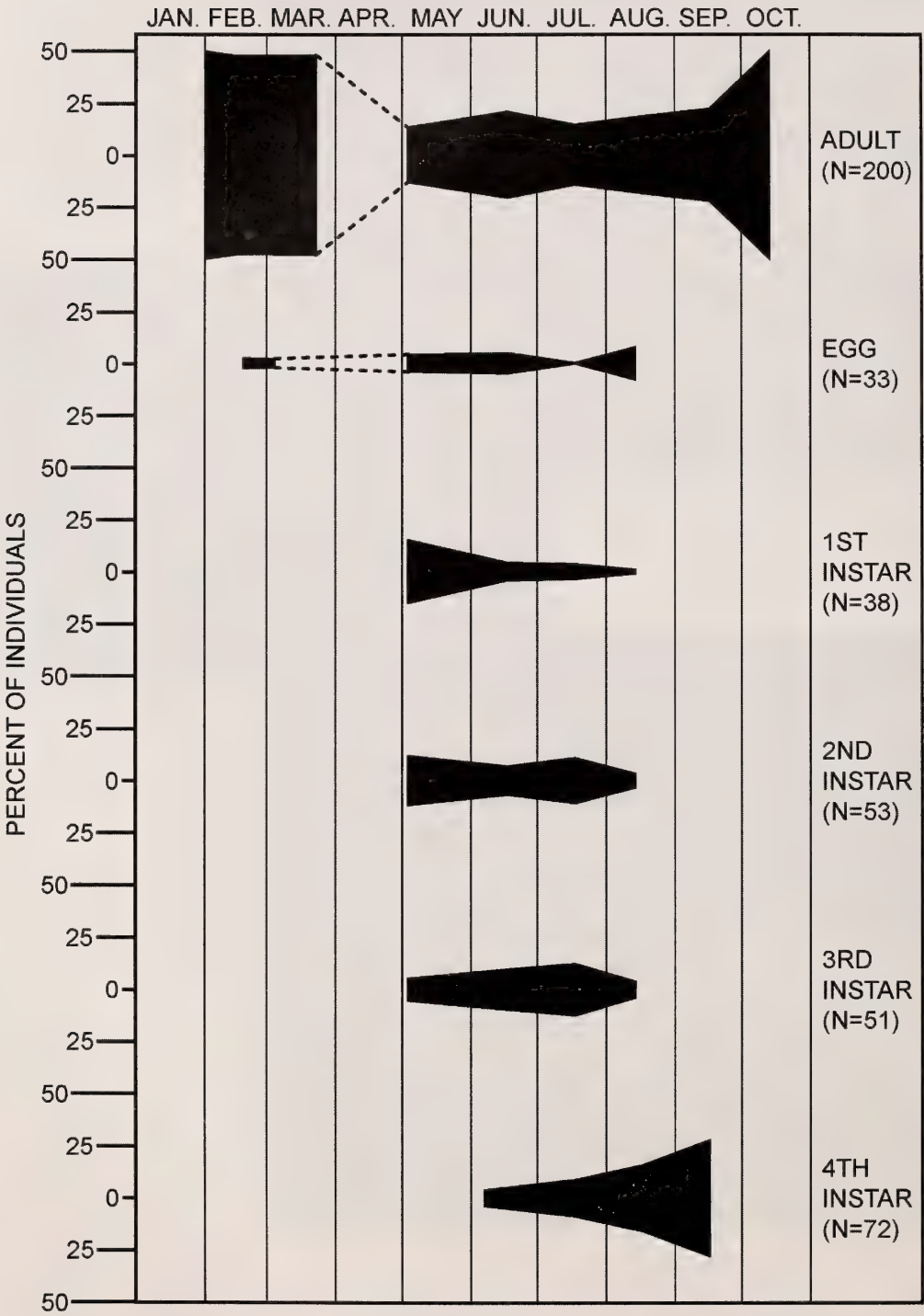


Fig. 2. Percent of individuals in each stage per sample of *M. hornii* collected near Waterton in Douglas County, Colorado, from 1990 to 1994. Dashed lines indicate that no collections were attempted in April.

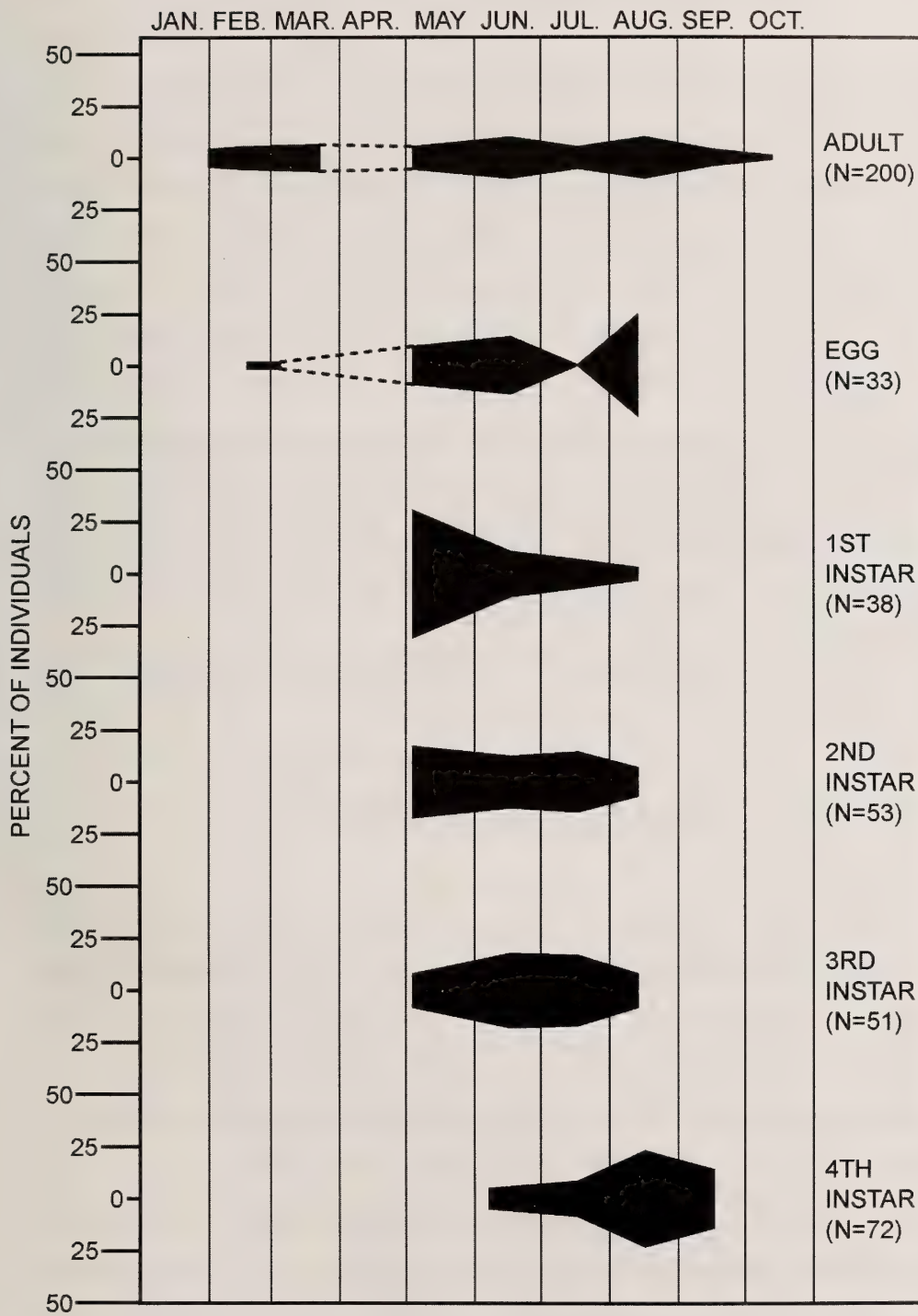


Fig. 3. Percent in each sample of total individuals of same stage of *M. hornii* collected near Waterton in Douglas County, Colorado, from 1990 to 1994. Dashed lines indicate that no collections were attempted in April.

Upon hatching, the first instars (maximum of five individuals) were placed in rearing containers modified from Anderson (1963). Plastic tubing was cut into one inch (2.54 cm) sections and each section filled with a mixture of plaster of paris and India ink to a depth of approximately 1 cm. We felt, although this was not tested, that darkening the plaster might be more conducive to these insects' survival because the adults in the laboratory preferred to remain hidden on the undersides and in crevices of the rocks in the bowl; this behavior was similar to that observed in the field. No mortality that could obviously be attributed to the ink was observed. The rim of each section was coated with petroleum jelly to prevent escape of the nymphs. The first instars were grouped by hatching date, the subsequent instars from each container by molting date. No container ever had more than five individuals. These dates allowed determination of stadia. Groups of containers were placed in petri dishes to which enough dechlorinated water had been added to allow the plaster to remain damp (i.e., water was absorbed by the plaster).

Nymphs and adults were fed frozen adult *Drosophila melanogaster* Meigen. Fresh flies were supplied daily and old flies removed. The number of flies provided was generally one more than the number of the instar (e.g., 2 flies for each first instar, 3 flies for each second instar). The bowl, petri dishes, and rearing containers were kept in incubators maintained at $18.3 \pm 1.5^{\circ}\text{C}$ and a 14L:10D photoperiod (260 ft-c).

Voucher specimens are deposited in the Southern Illinois University Entomology Collection.

RESULTS AND DISCUSSION

Life History

Macrovelia hornii overwinters as adults as reported by Anderson (1963) and Polhemus and Chapman (1979). In our study, the bugs entered overwintering sites in November and emerged the following year. The sites consisted of interstices beneath or between rocks in or near the rheocrenes but were never associated with dry earth. The insects generally were quiescent during the overwintering period but sometimes became active on relatively warm, calm, winter days. This was noted by Anderson (1963), who also observed copulating pairs in January and February. We found active adults from late January to mid-October (Figs. 2-3) and occasionally observed copulation from early March to early June. Eggs were found periodically from mid-February to mid-August, indicating that copulation occurred earlier than early March. They were glued singly and laterally to the moss attached to damp or dry rocks. Females showed a distinct preference for moss (species unidentified) as an oviposition site, as no eggs were attached to the rocks themselves in the field.

This species has only four instars. First through third instars were collected first in early May, fourth instars in early June (Figs. 2-3). Higher percentages of later

instars were found as the season progressed and by early September, only fourth instars (and adults) were collected; by mid-October, only adults were present.

This species apparently is univoltine, as noted by Anderson (1963), although the possibility of a partial or even complete second generation cannot be discounted because of the limited data.

Adults and nymphs were secretive, usually hiding in crevices and underneath rocks. As adults are dark-colored and not particularly active, they were even more difficult to see. Occasionally, nymphs and adults were seen in midsummer traversing the damp gravel, and, even then, most individuals were hiding.

As noted earlier, other authors have reported that these insects apparently prefer protective vegetation and are either incapable of walking on the surface of the water (McKinstery 1942 and Usinger 1956) or do so only occasionally (Slater and Baranowski 1978, Froeschner 1988). However, JTP repeatedly has observed them at night, by flashlight, traversing open water in an observation aquarium, sometimes for protracted periods of time, without breaking the surface film.

No prey species were noted during this study. Possible prey species commonly found with these bugs were midge (Chironomidae) and marsh beetle (Scirtidae) larvae, stonefly (Nemouridae) naiads, and springtails (Isotomidae). The only other predator and potential competitor commonly found in this habitat was *Microvelia torquata* Champion (Veliidae).

Adults vary in extent of wing development, with macropterous, brachypterous, and micropterous forms known (Slater and Baranowski, 1978). Of the 210 adults collected in 1990 and 1992 at the Waterton site, all but one were brachypterous, the wings reaching about the middle of the abdomen. The exception was a micropterous female collected 10 May 1990; her wings were reduced to pads that extended just past the posteromedial margin of the pronotum (see Slater and Baranowski [1978] for illustrations of these short-wing forms).

Laboratory Rearing

Adults were frequently seen in copula and, as mentioned by Polhemus and Chapman (1979), very reluctant to separate when disturbed. As in the field, eggs were glued laterally to the substrate, with females showing a preference for moss. Of 431 eggs for which substrate was recorded (not all these eggs were used in laboratory rearing), 55.1 percent were glued to moss, 41.8 percent to the rock surface, and 3.2 percent to the glass bottom along the water's edge. They were white at oviposition but soon began to turn yellowish. In ≈ 6 days (mean $\pm$ SE = 6.00 ± 0.07 , range = 4-8 days, $n = 83$), faint eyespots were apparent. As the embryo continued to develop, it became increasingly visible through the chorion, particularly the antennae, beak, legs, and body pubescence. The incubation period averaged 17.4 days (Table 1).

The first instar emerged through an anteroventral slit in the chorion. The four stadia averaged 8.3, 7.9, 8.5, and 13.1 days, respectively (Table 1). The total developmental period, from egg to adult averaged 55.2 days. These stadia averaged longer than those reported by Anderson (1963), but as he did not report the

temperature for his rearing experiment, it is impossible to make meaningful comparisons. All adults ($n = 41$) were brachypterous.

The primary cause of mortality appeared to be excess moisture in the containers. A similar conclusion was reached by Anderson (1963).

Table 1. Duration (in days) of each immature stage of *M. hornii* under controlled laboratory conditions.

Stage	Number Completing Stadium	Range	Mean $\pm$ SE	Cumulative Mean Age
Eggs	114 ^a	16-20	17.4 $\pm$ 0.07	17.4
1st nymphal instar	90	7-13	8.3 $\pm$ 0.14	25.7
2nd nymphal instar	79	6-10	7.9 $\pm$ 0.11	33.6
3rd nymphal instar	65	6-11	8.5 $\pm$ 0.13	42.1
4th nymphal instar	41	11-17	13.1 $\pm$ 0.18	55.2

^a137 eggs were laid.

We observed that adults will carry their prey on their beaks after impaling them. This previously was noted by Anderson (1963).

ACKNOWLEDGMENTS

We are indebted to W. A. and K. V. Polhemus for assistance in gathering specimens and field data. We thank two anonymous reviewers for their helpful comments.

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THREE NEW SPECIES OF THE SUBGENUS *HYGIA* (*MICROCOLPURA*) BREDDIN FROM SOUTHEASTERN ASIA, AND NEW TAXONOMIC REARRANGEMENTS (HEMIPTERA: COREIDAE: COREINAE: COLPURINI)¹

Harry Brailovsky² and Ernesto Barrera²

ABSTRACT: Three new species of *Hygia* (*Microcolpura*) Breddin from Indonesia, Malaysia, and Philippine Republic are described, and a key to the 14 known species is given. Numerous species previously placed in the subgenus *Hygia* (*Microcolpura*) are transferred to the subgenus *Hygia* (*Pterocolpura*), and 12 new subgeneric combinations are made as follows: *H. (P.) angulicollis* (Breddin 1900) **nov. comb.**, *H. (P.) annulipes* (Dallas 1852) **nov. comb.**, *H. (P.) armillata* (Breddin 1900) **nov. comb.**, *H. (P.) brevipennis* (Bergroth 1921) **nov. comb.**, *H. (P.) denticollis* (Bergroth 1918) **nov. comb.**, *H. (P.) kinabaluna* (Brailovsky and Barrera 2002) **nov. comb.**, *H. (P.) montana* (Blöte 1936) **nov. comb.**, *H. (P.) noctua* (Distant 1901) **nov. comb.**, *H. (P.) nodulosa* (Distant 1899) **nov. comb.**, *H. (P.) pajuana* (Brailovsky and Barrera 2002) **nov. comb.**, *H. (P.) tuberculicollis* (Breddin 1900) **nov. comb.**, and *H. (P.) varipes* (Westwood 1842) **nov. comb.** The new name *Hygia* (*Pterocolpura*) *frontalis* is proposed for *Hygia* (*Pterocolpura*) *angulicollis* Blöte 1936, preoccupied by *Hygia* (*Microcolpura*) *angulicollis* Breddin 1900, here transferred to *Hygia* (*Pterocolpura*). Two species, *humilis* (Breddin 1906) and *inermis* (Walker 1871), previously included in *Hygia* (*Microcolpura*), are excluded and considered insertae sedis.

KEY WORDS: Insecta, Hemiptera, Coreidae, Colpurini, *Hygia* (*Microcolpura*) and *Hygia* (*Pterocolpura*), new species, southeastern Asia, Indonesia, Malaysia, and Philippine Republic

The genus *Hygia* Uhler (1861) includes ten subgenera (*Australocolpura* Brailovsky, *Caracolpura* Breddin, *Colpura* Bergroth, *Eucolpura* Breddin, *Hygia* Uhler, *Microcolpura* Breddin, *Pterocolpura* Blöte, *Sphinctocolpura* Breddin, *Stenocolpura* Breddin, and *Trichocolpura* Breddin), and approximately 87 species widely distributed in the Oriental Region throughout Japan, China, Taiwan, India, Burma, Korea, Cambodia, Malaysia, Indonesia, Philippines, New Guinea, and Australia (Brailovsky and Barrera 2002).

Our knowledge of relationships subgenera of the genus *Hygia* is still incomplete. Brailovsky and Barrera (1997) revised the subgenus *Eucolpura* of *Hygia* and discussed its relationship to the subgenus *Colpura*, and later Brailovsky and Barrera (2002) revised the subgenus *Microcolpura* of the genus *Hygia*, described five new species and placed the number of known at 26 species.

Current studies of the subgenus *Pterocolpura* allow us to recognize close affinities with *Microcolpura* based on evidence that we did not consider during the revision of the latter. Both subgenera share the following characters: genae without spines, postocular tubercle protuberant, buccula rounded, short, and with sharp spiny anterior projection, femora unarmed, and abdominal sternite VII of the female with plica and fissura.

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The only feature that separates them is the frontal angles of the pronotum which in *Microcolpura* are obtuse and rounded (Fig. 1), whereas in *Pterocolpura* they are produced forward as tiny, medium-sized, or remarkably large conical lobes, thickened, and reaching or not the postocular tubercle (Figs. 2-4).

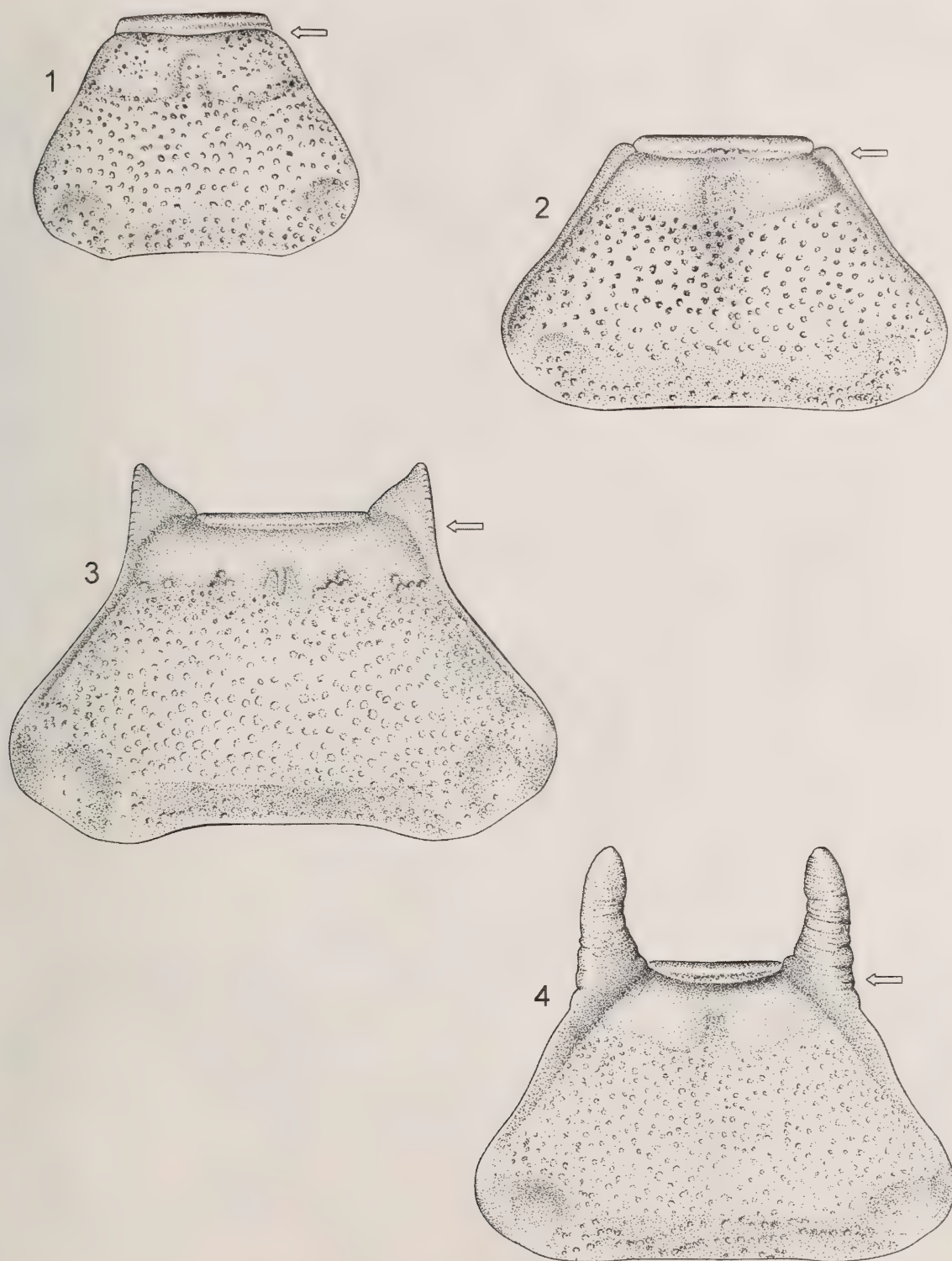
The subgenus *Pterocolpura* has included only 3 species: *H. (P.) frontalis* Brailovsky and Barrera (**nomen novum**) [before *H. (P.) angulicollis* Blöte (1936), *H. (P.) pentafurcata* Brailovsky (2002), and *H. (P.) sarawak* Brailovsky (2002)]. To this group, 12 new subgeneric combinations are added as follows: *H. (P.) angulicollis* (Breddin 1900) **nov. comb.**, *H. (P.) annulipes* (Dallas 1852) **nov. comb.**, *H. (P.) armillata* (Breddin 1900) **nov. comb.**, *H. (P.) brevipennis* (Bergroth 1921) **nov. comb.**, *H. (P.) denticollis* (Bergroth 1918) **nov. comb.**, *H. (P.) kinabaluna* (Brailovsky and Barrera 2002) **nov. comb.**, *H. (P.) montana* (Blöte 1936) **nov. comb.**, *H. (P.) noctua* (Distant 1901) **nov. comb.**, *H. (P.) nodulosa* (Distant 1899) **nov. comb.**, *H. (P.) pajuana* (Brailovsky and Barrera 2002) **nov. comb.**, *H. (P.) tuberculicollis* (Breddin 1900) **nov. comb.**, and *H. (P.) varipes* (Westwood 1842) **nov. comb.** To clarify the taxa involved in the subgenus, *Pterocolpura* will be revised in a further contribution.

Another species previously included in *Microcolpura* and transferred to the subgenus *Hygia* was reconfirmed by Kerzhner and Brailovsky (2003) as *Hygia (Hygia) lativentris* (Motschulsky 1866).

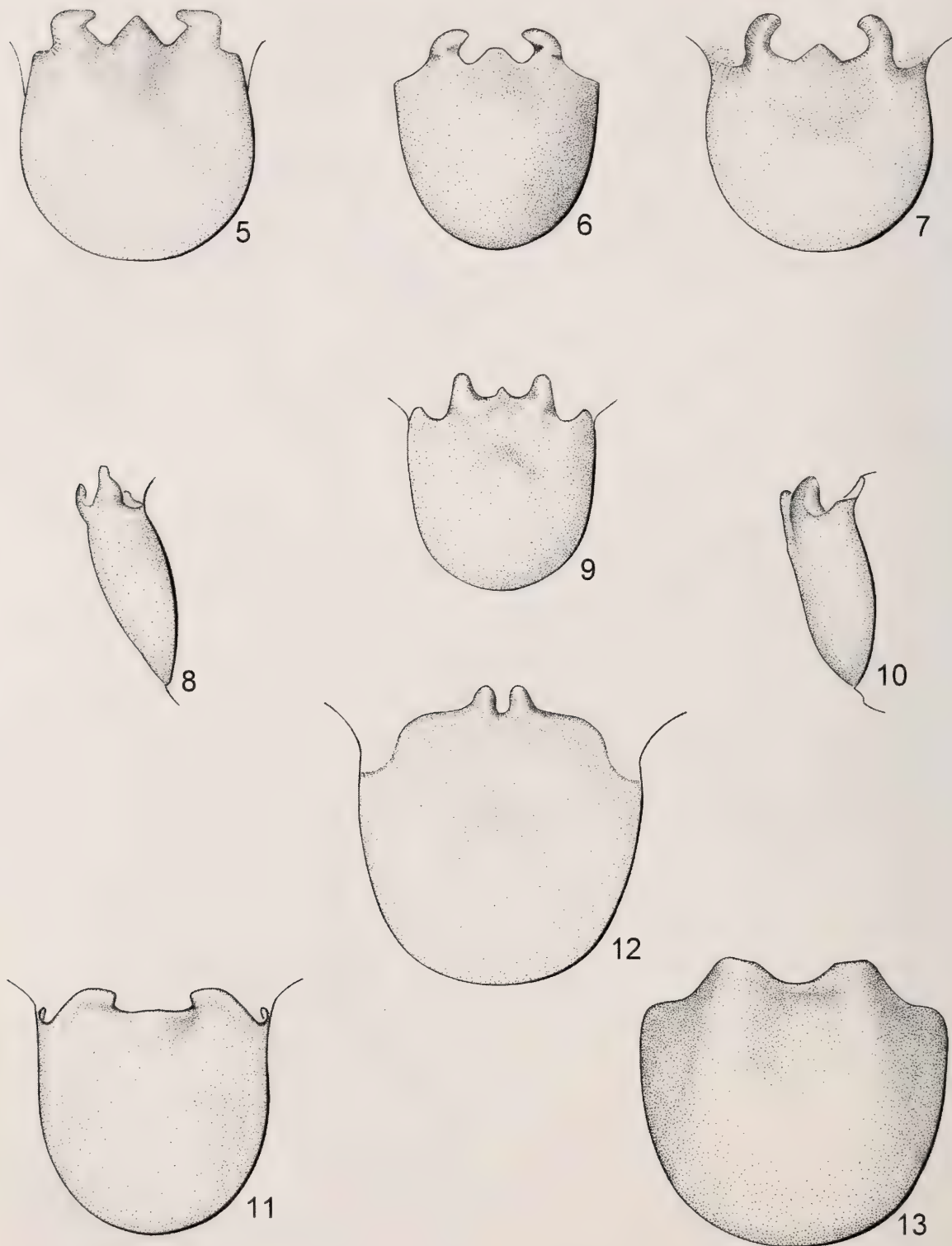
Two species, *humilis* (Breddin 1906) and *inermis* (Walker 1871), which were included in *Hygia (Microcolpura)*, are excluded and considered insertae sedis. A new subgenus or genus likely will be described to accommodate these species.

The subgenus *Microcolpura* now includes 14 species, among them three new to the science: *H. (M.) binaluana* new species, *H. (M.) dulita* Brailovsky and Barrera 2002, *H. (M.) flavitarsis* Blöte 1936, *H. (M.) hebeti-collis* (Breddin 1905), *H. (M.) imbellis* (Breddin 1900), *H. (M.) incultus* new species, *H. (M.) inermi-collis* (Breddin 1900), *H. (M.) labecula* (Distant 1901), *H. (M.) modesta* (Distant 1901), *H. (M.) pacalis* (Breddin 1906), *H. (M.) selangorana* new species, *H. (M.) siberuta* Brailovsky and Barrera 2002, *H. (M.) siporana* Brailovsky and Barrera 2002, and *H. (M.) speculigera* (Breddin 1906). These species are morphologically very similar and therefore sometimes difficult to distinguish, especially females. The most reliable distinguishing character is the shape of the posteroventral edge of the male genital capsule.

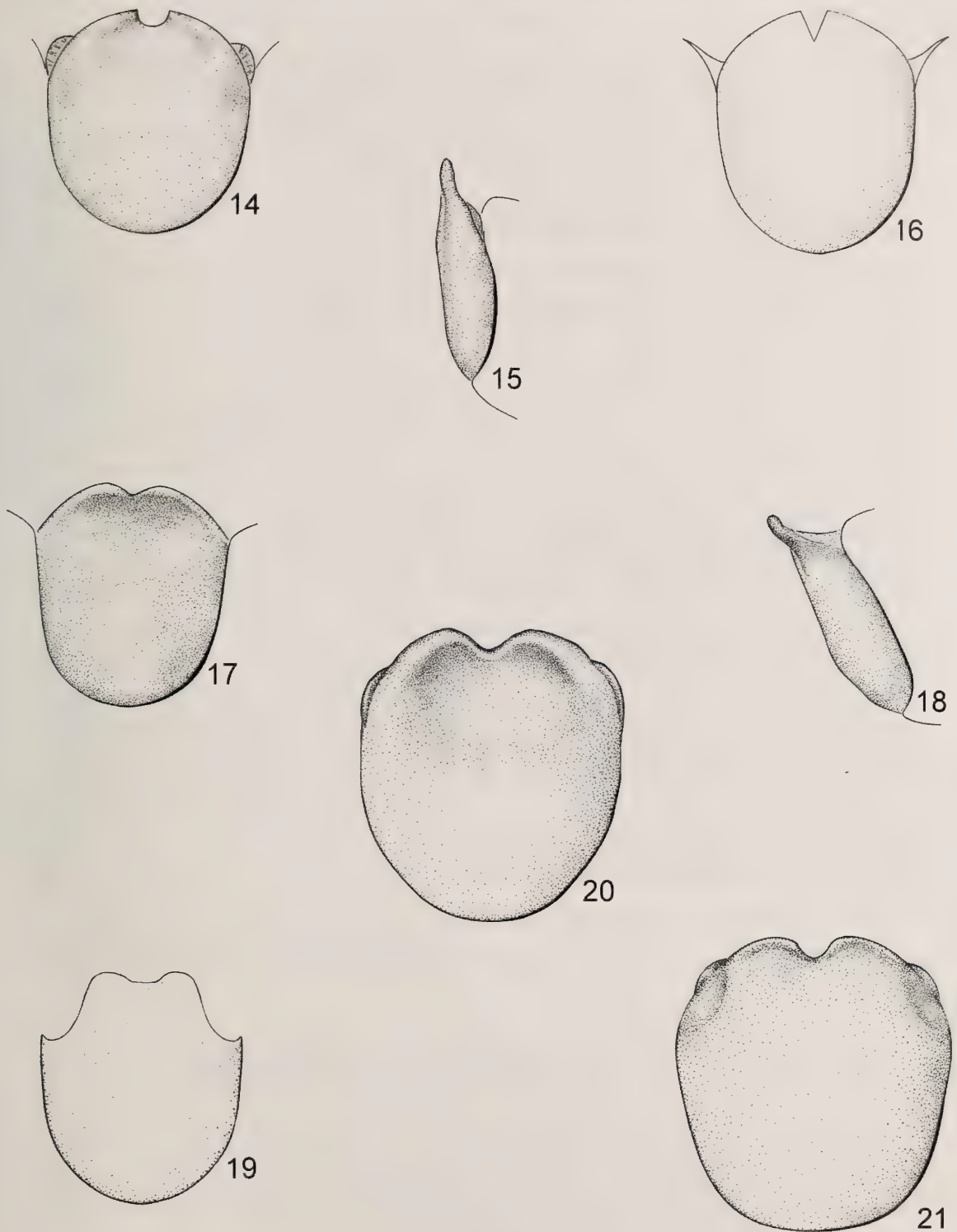
The following abbreviations are used for the institutions cited in this paper: BMNH (The Natural History Museum, London, England); BPBM (Bernice P. Bishop Museum, Honolulu, Hawaii); RNHL (Rijksmuseum van Natuurlijke Histoire, Leiden, Netherlands); UNAM (Instituto de Biología, Universidad Nacional Autónoma de México); ZMAS (Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia); and ZSMC (Zoologische Staatssammlung, München, Germany).



Figures 1-4. Pronotum. 1. *Hygia (Microcolpura) flavitarsis* Blöte. 2-3. *Hygia (Pterocolpura)* spp. 2. *H. (P.) montana* (Blöte). 3. *H. (P.) angulicollis* (Breddin). 4. *H. (P.) sarawak* Brailovsky.



Figures 5-13. *Hygia* (*Microcolpura*) spp., male genital capsule in caudal view (5-7, 9, 11-13) and lateral view (8, 10). 5. *H. (M.) siberuta* Brailovsky and Barrera. 6. *H. (M.) imbellis* (Breddin). 7. *H. (M.) siporana* Brailovsky and Barrera. 8. *H. (M.) imbellis* (Breddin). 9-10. *H. (M.) pacalis* (Breddin). 11. *H. (M.) labecula* (Distant). 12. *H. (M.) dulita* Brailovsky and Barrera. 13. *H. (M.) incultus* NEW SPECIES.



Figures 14-21. *Hygia (Microcolpura)* spp., male genital capsule in caudal view (14, 16-17, 19-21) and lateral view (15, 18). 14-15. *H. (M.) inermicollis* (Breddin). 16. *H. (M.) speculigera* (Breddin). 17-18. *H. (M.) hebeticollis* (Breddin). 19. *H. (M.) flavitarsis* Blöte. 20. *H. (M.) binaluana* NEW SPECIES. 21. *H. (M.) selangorana* NEW SPECIES.

KEY TO THE SPECIES OF *HYGIA* (*MICROCOLPURA*)

1. Hind tibiae black to reddish brown with two yellow rings.....*Hygia* (*Microcolpura*) *hebeticolis* (Breddin).....2
- 1a. Hind tibiae entirely black to reddish brown.....2
2. Hemelytral membrane dark to pale brown with central yellow discoidal spot 3
- 2a. Hemelytral membrane entire pale to dark brown or ambarine 7
3. Posteroventral edge of male genital capsule pentalobulate or trilobulate (Figs. 6, 9, and 10)....4
- 3a. Posteroventral edge of male genital capsule simple (Figs. 11, 16, 21).....5
4. Posteroventral edge of male genital capsule trilobulate (Figs. 6, 8).....*Hygia* (*Microcolpura*) *imbellis* (Breddin).....
- 4a. Posteroventral edge of male genital capsule pentalobulate (Figs. 9-10)*Hygia* (*Microcolpura*) *pacalis* (Breddin).....
5. Posteroventral edge of male genital capsule with small U-shaped mesial concavity, lateral angles shallowly incurved mesad (Fig. 21).....*Hygia* (*Microcolpura*) *selangorana* NEW SPECIES.....
- 5a. Posteroventral edge of male genital capsule not with small U-shaped mesial concavity (Figs. 11, 16) 6
6. Posteroventral edge of male genital capsule with small V-shaped mesial acute concavity, lateral angles not incurved mesad (Fig. 16)*Hygia* (*Microcolpura*) *speculigera* (Breddin).....
- 6a. Posteroventral edge of male genital capsule with deep elongate U-shaped concavity, lateral angles with short lobes (Fig. 11)*Hygia* (*Microcolpura*) *labecula* (Distant).....
7. Endocorium without subapical yellow discoidal spot.....8
- 7a. Endocorium with subapical yellow discoidal spot.....9
8. Connexivum and pleural abdominal sterna unicolor, entirely pale orange red; pronotal disk densely covered with long erect setae ...*Hygia* (*Microcolpura*) *siberuta* Brailovsky and Barrera.....
- 8a. Connexivum and pleural margin of abdominal sterna bicolorous, reddish brown with posterior margin or posterior half yellow; pronotal disk glabrous or with a few scattered short hairs*Hygia* (*Microcolpura*) *binaluana* NEW SPECIES.....
9. Posteroventral edge of male genital capsule simple (Fig. 13-15, 19).....10
- 9a. Posteroventral edge of male genital capsule bituberculate or trilobulate (Figs. 7, 12) 12
10. Posteroventral edge of male genital capsule with wide mesial concavity (Fig. 13)*Hygia* (*Microcolpura*) *incultus* NEW SPECIES.....
- 10a. Posteroventral edge of male genital capsule not with wide mesial concavity (Figs. 14-15, 19) ..11
11. Posteroventral edge of male genital capsule moderately sinuate, with shallow non-truncated mesial concavity (Fig. 19).....*Hygia* (*Microcolpura*) *flavitaris* Blöte.....
- 11a. Posteroventral edge of male genital capsule with small U-shaped mesial concavity, and lateral angles incurving mesad (Figs. 14-15).....*Hygia* (*Microcolpura*) *inermicollis* (Breddin).....
12. Posteroventral edge of male genital capsule bituberculate (Fig. 12); hind femur black to reddish brown, with basal third yellow*Hygia* (*Microcolpura*) *dulita* Brailovsky and Barrera.....
- 12a. Posteroventral edge of male genital capsule trilobulate (Fig. 7); hind femur entirely black to reddish brown 13
13. Posteroventral edge of male genital capsule with median triangular lobe, elongate and exposed, lateral lobes narrowed incurving mesad and longer than median lobe (Fig. 7).....*Hygia* (*Microcolpura*) *siporana* Brailovsky and Barrera.....
- 13a. Posteroventral edge of male genital capsule with median lobe short, and lateral lobes broad, incurving mesad, and longer than median lobe*Hygia* (*Microcolpura*) *modesta* (Distant).....

Hygia (Microcolpura) incultus, NEW SPECIES

(Fig. 13)

Description. Male (holotype). Dorsal coloration. Black with apex of scutellum, and posterior margin of connexivum dark chestnut orange; antennal segments I to III black, IV yellow orange with basal joint pale reddish brown; inner third of apical margin of endocorium with yellow discoidal spot; hemelytral membrane entirely dark ambarine with veins darker, and reaching posterior margin of last abdominal segment. **Ventral coloration.** Black with rostral segments I to IV, trochanter, basal joint of femora, and anterior and posterior lobe of metathoracic peritreme yellow to chestnut orange; tarsi shiny chestnut orange. **Structure.** Rostrum incomplete: frontal angles obtuse, rounded; femora unarmed. Genital capsule broadly ovoid; posteroventral edge convex with a widened mesial concavity (Fig. 13).

Female. Unknown.

Measurements. Head length: 1.30 mm; width across eyes: 1.44 mm; interocular space: 0.90 mm; interocellar space: 0.44 mm; preocular distance: 0.86 mm; antennal segments lengths: I, 1.38 mm; II, 1.64 mm; III, 1.22 mm; IV, 1.10 mm. Pronotal length: 1.78 mm; width across humeral angles: 2.86 mm. Scutellar length: 1.52 mm; width: 1.32 mm. Total body length: 8.95 mm.

Type material. Holotype: male, Indonesia, West Sumatra, Loeboek Sikaping, 450 m, 1923-27, L. Hundeshagen. Deposited in ZMAS.

Discussion. The shape of the posteroventral edge of male genital capsule resembles *Hygia (Microcopura) hebeticolis* (Breddin 1905). *Hygia (M.) incultus* is distinguishable by the completely black tibiae, the hemelytral membrane entirely dark ambarine, and the mesial concavity of the posteroventral edge of male genital capsule widened (Figs. 13, 17-18). In *H. (M.) hebeticolis* the tibiae are reddish brown with two yellow rings, and the hemelytral membrane is pale brown.

Etymology. From the Latin “*incultus*,” for uncultivated, referring to the relatively indistinctive nature of the species.

Hygia (Microcolpura) selangorana, NEW SPECIES

(Fig. 21)

Description. Male (holotype). Dorsal coloration. Black to reddish brown with apex of scutellum, and posterior margin of connexivum dark chestnut orange; antennal segments I to III chestnut orange, IV yellow with basal joint chestnut orange; inner third of apical margin of endocorium with dirty yellow discoidal spot; hemelytral membrane dark brown with wide yellow discoidal spot, and reaching posterior margin of last abdominal segment; dorsal abdominal segments black with segment II and lateral margins of III dark orange. **Ventral coloration.** Black; rostral segments I to IV yellow, or yellow with orange reflec-

tions; trochanter, basal joint of hind femur, tibiae, tarsi, anterior and posterior lobe of metathoracic peritreme, and posterior margin of pleural abdominal sterna orange to dark chestnut orange. **Structure.** Rostrum reaching posterior margin of abdominal sternite V; frontal angles obtuse, rounded; femora unarmed. Genital capsule broadly ovoid; posteroventral edge with narrow U-shaped concavity, and lateral angles shallowly incurved (Fig. 21).

Female. Unknown.

Measurements. Head length: 1.36 mm; width across eyes: 1.60 mm; interocular space: 0.82 mm; interocellar space: 0.38 mm; preocular distance: 0.86 mm; antennal segments lengths: I, 1.52 mm; II, 2.12 mm; III, 1.34 mm; IV, 1.24 mm. Pronotal length: 2.00 mm; width across humeral angles: 3.00 mm. Scutellar length: 1.54 mm; width: 1.32 mm. Total body length: 9.35 mm.

Type material. **Holotype:** male, Malaysia, Selangor, F. M. S., Gombok Valley, 20-X-1921, H. M. Pendlebury. Deposited in BMNH. **Paratypes:** 1 male, Malaysia, Selangor, F. M. S., Ayer Farm, F. A. Limba and Old Baluku, 100'-600', 14-XI-1920, H. C. Abraham. Deposited in UNAM. 1 male, Malaysia, Malaya Peninsula, SE Pahang, Rompin Mining Co., Railway Track, 46 km, 3-III-1961, L. W. Quate. Deposited in BPBM.

Discussion. The endocorium with small discoidal yellow spot, and the shape of the posteroventral edge of male genital capsule (Figs. 14-15, 17-18, 21) resemble *Hygia (Microcolpura) hebeticolis* (Breddin 1905) and *H. (M.) inermicollis* Breddin 1900. The hemelytral membrane of those species is entirely pale brown, and in *H. (M.) selangorana* the membrane is dark brown with a wide central yellow spot.

In *H. (M.) imbellis* (Breddin), the hemelytral membrane is similar to that of *H. (M.) selangorana*, but the posteroventral edge is clearly trilobulate and not simple (Figs. 6, 8, 21).

Etymology. Named after the type locality.

Hygia (Microcolpura) binaluana, NEW SPECIES

(Fig. 20)

Description. Male (holotype). Dorsal coloration. Head and anterior lobe of pronotal disk black; posterior lobe of pronotal disk, scutellum, clavus, and corium dark chestnut orange; antennal segment I reddish brown, II and III chestnut orange, and IV yellow with basal joint chestnut orange; apex of scutellum yellow; endocorium lacking a yellow discoidal spot; hemelytral membrane entirely brown; connexivum reddish brown with posterior margin yellow; abdominal segments reddish brown. **Ventral coloration.** Reddish brown with rostral segments I to IV, anterior and posterior lobe of metathoracic peritreme, trochanters, basal joint of fore and middle femora, anterior third of hind femur, and posterior lateral margin of abdominal sterna yellow; tibiae orange yellow with basal and apical joint darker; tarsi yellow with pale chestnut orange reflections. **Structure.**

Rostrum reaching posterior margin of abdominal sternite IV or anterior third of V; frontal angles obtuse, rounded; femora unarmed. Genital capsule broadly ovoid; posteroventral edge with narrow elongate median longitudinal impression and undercurved area along the posterior one-third of lateral angles (Fig. 20).

Female. Coloration. Similar to male (Holotype). Abdominal segments VIII and IX, connexival segments VIII and IX dark reddish; genital plates reddish brown with chestnut orange reflections. **Structure.** Genitalia. Abdominal sternite VII with plica and fissura; plica triangular, acute, reaching the middle third of the sternite; gonocoxae I enlarged dorsoventrally, convex, in caudal view closed; paratergite VIII triangular, small, with spiracle visible; paratergite IX squarish, larger than paratergite VIII, with inner third clearly touching.

Measurements. Male given first, followed in parentheses by those for female. Head length: 1.56 mm (1.66 mm); width across eyes: 1.70 mm (1.80 mm); interocular space: 0.88 mm (0.88 mm); interocellar space: 0.42 mm (0.44 mm); preocular distance: 0.94 mm (0.96 mm); antennal segments lengths: I, 1.74 mm (1.70 mm); II, 2.44 mm (2.56 mm); III, 1.60 mm (1.62 mm); IV, 1.34 mm (1.32 mm). Pronotal length: 2.16 mm (2.36 mm); width across humeral angles: 3.24 mm (3.58 mm). Scutellar length: 1.68 mm (1.80 mm); width: 1.64 mm (1.82 mm). Total body length: 10.03 mm (10.75 mm).

Type material. Holotype: male, Philippine Republic, N Palawan, Binaluan, XI-XII-1913, G. Boettcher. Deposited in ZSMC. **Paratypes:** 3 males, 3 females, Philippine Republic, N Palawan, Binaluan, XI-XII-1913, G. Boettcher. Deposited in BMNH, UNAM and ZSMC:

Discussion. The hemelytral membrane entirely brown, the obtuse frontal angles, and the shape of the male genital capsule relate this species to *H. (M.) hebeticolis* (Breddin 1905) (Figs. 17-18, 20). In *H. (M.) binaluana* the endocorium lacks a yellow discoidal spot, the pronotal disk is covered with short scattered hairs, and the tibiae are orange yellow with basal and apical joint darker. In *H. (M.) hebeticolis* the endocorium has a small yellow discoidal spot, the pronotal disk is densely covered by long and erect hairs, and the tibiae are reddish brown with two yellow rings.

Etymology. Named after Binaluan in the Philippine Republic.

ADDITIONAL NOMENCLATURAL REMARKS

Hygia (Pterocolpura) frontalis Brailovsky and Barrera, **nomen novum**

Hygia (Pterocolpura) angulicollis Blöte 1936. Zool. Meded. 19: 42-43. Preoccupied.

The male holotype of *H. (P.) angulicollis* Blöte (1936) housed in RNHL was examined. We determined that the specific name *H. (P.) angulicollis* is a junior homonym of *Hygia (Microcolpura) angulicollis* (Breddin 1900), since the transfer of this latter taxon to the subgenus *Pterocolpura*. In the absence of a junior synonym for *H. (P.) angulicollis* Blöte 1936, not Breddin 1900, we suggest the following replacement name: *Hygia (Pterocolpura) frontalis* Brailovsky and Barrera, **nomen novum**.

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THE MEXICAN PINE BEETLE, *DENDROCTONUS MEXICANUS*: FIRST RECORD IN THE UNITED STATES AND CO-OCCURRENCE WITH THE SOUTHERN PINE BEETLE - *DENDROCTONUS FRONTALIS* (COLEOPTERA: SCOLYTIDAE OR CURCULIONIDAE: SCOLYTINAE)¹

John C. Moser,² Bobbe A. Fitzgibbon,³ and Kier D. Klepzig²

ABSTRACT: The Mexican pine beetle (XPB) *Dendroctonus mexicanus*, is recorded here for the first time as a new introduction for the United States (US). Individuals of XPB and its sibling species, the southern pine beetle (SPB) *Dendroctonus frontalis*, were found infesting the same logs of Chihuahua pine, *Pinus leiophylla* var. *chihuahuana* and those of several other pine species in the Chiricahua Mountains, AZ. Both species were also captured in Lindgren traps baited with southern- and western pine beetle attractants, both of which contained the pheromone frontalin. XPB outnumbered SPB 16:1 in the traps. Both XPB and SPB were trapped during warm periods in winter. It is possible that XPB attack trees during winter as SPB do in the southeastern US. Both XPB and SPB are highly destructive to pines, and XPB could pose a threat if accidentally introduced to pines in the higher elevations of the eastern US.

KEY WORDS: Southern pine beetle, *Dendroctonus frontalis*, *Dendroctonus mexicanus*, invasive species, bark beetle, Curculionidae, Scolytidae, Scolytinae

Dendroctonus mexicanus Hopkins (Coleoptera: Curculionidae or Scolytidae: Scolytinae), the Mexican pine beetle (XPB), and *D. frontalis* Zimmermann (Coleoptera: Curculionidae or Scolytidae: Scolytinae), the southern pine beetle (SPB), are sibling species so closely related that they are nearly impossible to tell apart by visual examination and/or behavior. Until the discovery that males of the two species could be reliably differentiated by examining their seminal rods (Payne, 1980; Lanier et al., 1988), the two species were separated only with difficulty, presumably by the relative lengths of the setae on their elytral declivities (Cibrian et al., 1995).

The range of the XPB is limited in Mexico from the northern state of Sonora to the southern state of Chiapas (Cibrian et al., 1995). The SPB occurs north of, south of, and within the range of the XPB (Salinas-Moreno et al., 2004) (Fig. 1). Although the XPB normally exists at higher elevations than the SPB (Wood, 1982), the coexistence of these two species in the same tree was noted by Wood (1982) and even in adjacent galleries of the same tree (Zuniga et al., 1995). The biologies of the two species differ only slightly, and they both periodically cause extensive economic damage to pine forests (Cibrian et al., 1995).

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Figure 1. Approximate distribution of *Dendroctonus mexicanus* (XPB, black areas) (from Salinas-Moreno et al. 2004) and *D. frontalis* (gray areas) (from Payne 1980) in the United States and Mexico. Arrow indicates approximate location of new record of the XPB in Chiricahua National Monument, Arizona, U.S.A.

On August 23, 2000, an aerial survey by the U.S. Forest Service discovered approximately seven hectares of damage by bark beetles in Southern Arizona on the Chiricahua National Monument, as well as over 4,700 hectares acres on the Coronado National Forest, and 26 hectares on private land. We document here the dominant species of bark beetles involved in these infestations, the first record of the XPB in the U.S.A., and provide additional data that the XPB and the SPB coexist within the same trees, and that both respond to semiochemical-baited traps.

METHODS

Study areas. We selected two sites of bark beetle infestation on the Coronado National Forest, Arizona, U.S.A. Both sites – Pinery Canyon (31° 57.327' N, 109° 18.729' W) and Turkey Creek (31° 51.280' N, 109° 19.883' W), about 12 km south of Pinery Canyon – were located on ridge tops at elevations of approximately 1750 m. Host species on the sites included *Pinus engelmannii* Carrière, *Pinus leiophylla* Schiede & Deppe var. *chihuahuana* (Engelm.) Shaw, *P. ayacahuite* Ehrenberg ex Schlechtendal, and *Pinus ponderosa* P. & C. Lawson var. *scopulorum* Engelm. *P. leiophylla* var. *chihuahuana* appeared to be the species most impacted by bark beetles at both sites.

Trapping. At each site we placed four Lindgren 12-unit multiple-funnel traps (Phero Tech, Inc., Delta, British Columbia, Canada), each separated by about 40 m, at each site. We baited two of the traps with a standard (SPB) lure (racemic frontalin, loaded with 296 mg active ingredient/ bait, releasing at 5.2 mg /d @ 23°C; Phero Tech, Inc.). Because the response of *D. frontalis* to frontalin in the southeastern US is synergized by α -pinene (a host monoterpene), we also baited those traps with a 170 g poly bag loaded with 70 percent (-) α -pinene (releasing at 1000 mg /d @ 23°C; Phero Tech, Inc.). Since we suspected the presence of the western pine beetle *Dendroctonus brevicomis* LeConte (WPB) in this area, we baited the other two traps at each site with the standard WPB three-component lure: racemic frontalin, exo-brevicomin, and myrcene releasing at 2.6 mg, 17 mg, and 100 mg per day (@ 23°C; Phero Tech, Inc.). The pheromone baits were placed near the tops of the traps, and the baits were replaced at least every three months. We sampled the traps weekly from May 15, 2001 until February 22, 2002.

By January 2002, the Pinery Canyon infestation had begun to decline. We moved the four traps about 12 km south on February 22, 2002 to the Turkey Creek location, which now possessed a much larger number of actively infested trees. The placement and pheromone components of the traps were the same as at Pinery Canyon, except that the baits were replaced monthly.

Each week, contents of each of the four traps were placed in a Nasco Whirlpak® with 70 percent ethanol, by personnel of the Coronado National Forest, and sent to the senior author at Pineville (Louisiana, U.S.A.), for processing. Here *Dendroctonus* species were separated from the other insects, and cleared for a minimum of 12 hrs in lactophenol to facilitate visualizing the genitalia. The beetles were sexed and the males identified to species using seminal rod morphology. Due to a lack of reliable taxonomic characters, we did not attempt to identify the females to species.

Collection from host trees. On October 3, and November 19, 2001, bark samples were removed from eight and two *P. chihuahuana*, respectively, from the Turkey Creek location from the lower bole to the crown. Live and dead *Dendroctonus* spp. were removed from the galleries in these bark pieces and sent to Pineville, LA, for identification to species. These trees were in various stages of infestation. On December 6, 2001, five additional *P. chihuahuana* in various stages of infestation were cut in Pinery Canyon. Bark samples were also removed

from these trees, and live and dead *Dendroctonus* spp. were removed from the galleries and sent to Pineville, (Louisiana, U.S.A.), for identification to species.

Daily maximum and minimum temperatures and rainfall data were obtained from the Coronado National Monument (CNM) weather station, about 7 km north of, and at the same elevation as, the Pinery Canyon site.

RESULTS AND DISCUSSION

The trapping at the Pinery Canyon site (May 2001 – Feb 2002) with both SPB and WPB baits confirmed the presence of both the XPB and the SPB at the Pinery Canyon site (Fig. 2). This represents the first record of the XPB within the US, and the first recorded attraction of the XPB to semiochemical baited traps. Ground checks of bark beetle galleries of infested *P. leiophylla* var *chihuahuana* revealed that both the SPB and the XPB were infesting the lower, mid, and upper boles of the same trees. Collection from *P. leiophylla* var *chihuahuana* at Turkey Creek in October and November 2001 yielded a total of 31 male XPB, two male SPB, and 69 female *Dendroctonus* spp. A total of 10 male XPB, seven male SPB, and 37 female *Dendroctonus* spp. were collected from *P. leiophylla* var *chihuahuana* at Pinery Canyon in December 2001.

At the Pinery Canyon site, one trap baited with WPB pheromone consistently caught the most beetles. In contrast, at Turkey Creek a trap baited with SPB pheromone consistently caught the largest number of beetles. In all but one collection (in September 2000 when only a few SPB were captured) XPB was always the predominant bark beetle captured, outnumbering SPB about 34:1.

Trapped SPB (74) and XPB (997) males together outnumbered the combined total of females of both species (484) by about 2:1 at Pinery Canyon. The SPB (416) and XPB (15,944) males trapped at Turkey Creek together outnumbered XPB and SPB females (1,526) about 10:1. These ratios are consistent with those recorded for populations of SPB only in the southeastern US (Payne, 1980). However, for beetles collected from trees, females were recovered over twice as often as males. This sex ratio is greater than the 1:1 ratio recorded for emerging SPB in the southeastern USA (Coster et al., 1977; Osgood and Clark, 1963). However, we only sampled beetles within trees; it is possible that males may have re-emerged and vacated the galleries before the females, and therein changed the sex ratio.

Maximum temperatures at the collecting sites at the times of flight (~1000 to ~1700 hrs.) varied from ~19°C in winter to ~38°C in summer. Trap catches of the XPB stopped when average temperatures dropped below 16°C, and SPB seemed even less active at cold temperatures. In both years of trapping, we observed a distinct spring peak for male XPB and SPB (Fig. 2). Though numbers of SPB were at least an order of magnitude lower than those of XPB, the correspondence in their peak flight activity was striking. Perhaps by way of explanation, we noted a correspondence between peak trap captures and average daily temperature [obtained by adding the maximum and minimum daily temperatures and dividing by two (Figs.

3 and 4)]. Both species showed the highest propensity for flight during average daily temperatures in the range of 20-25°C, with the most beetles captured at approximately 22°C. This unimodal pattern of flight activity is in agreement with previous observations for SPB in the southern US (Moser and Thompson, 1986).

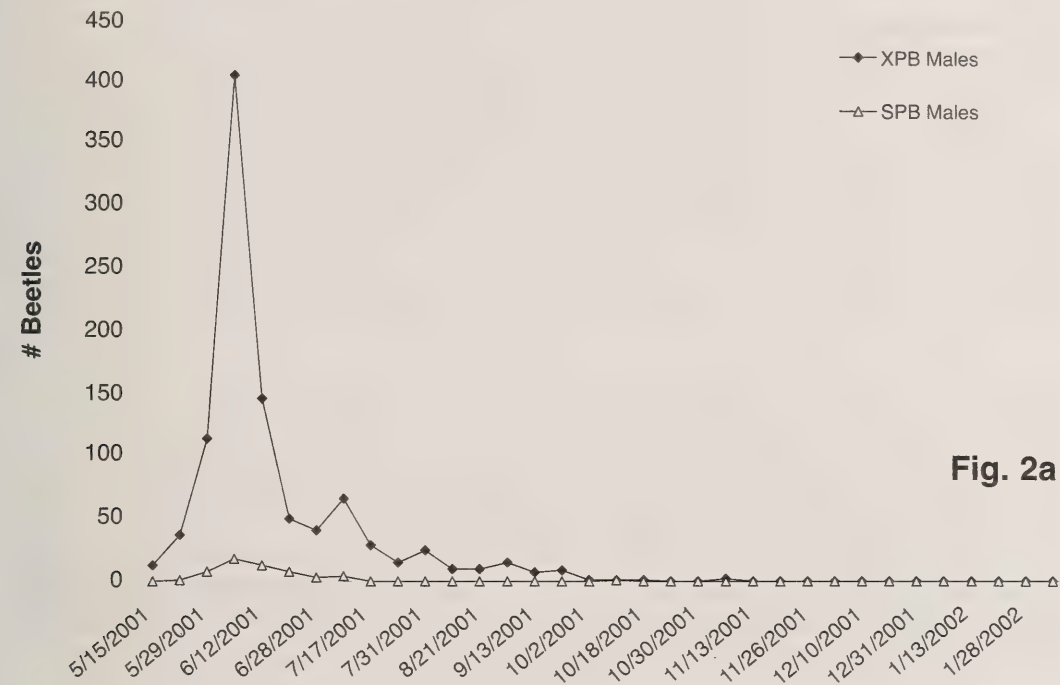


Fig. 2a

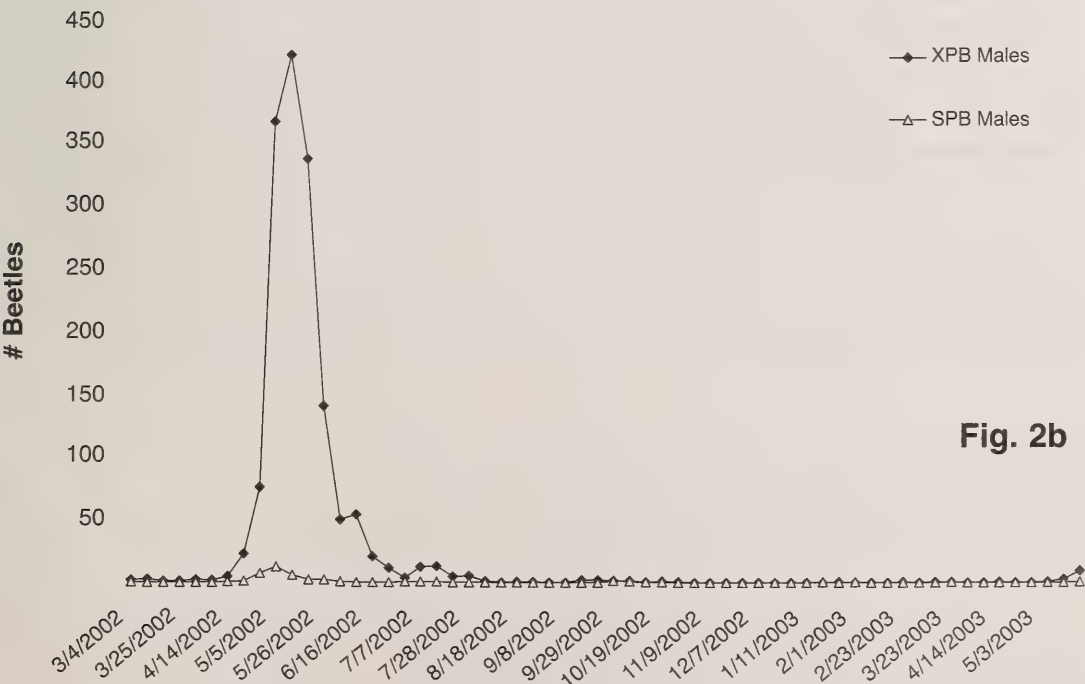


Fig. 2b

Figure 2. Total number of male *Dendroctonus mexicanus* (XPB) and *D. frontalis* (SPB) captured in funnel traps at a) Pinery Canyon, Coronado National Forest, Arizona, U.S.A.; b) Turkey Creek, Coronado National Forest, Arizona, U.S.A.

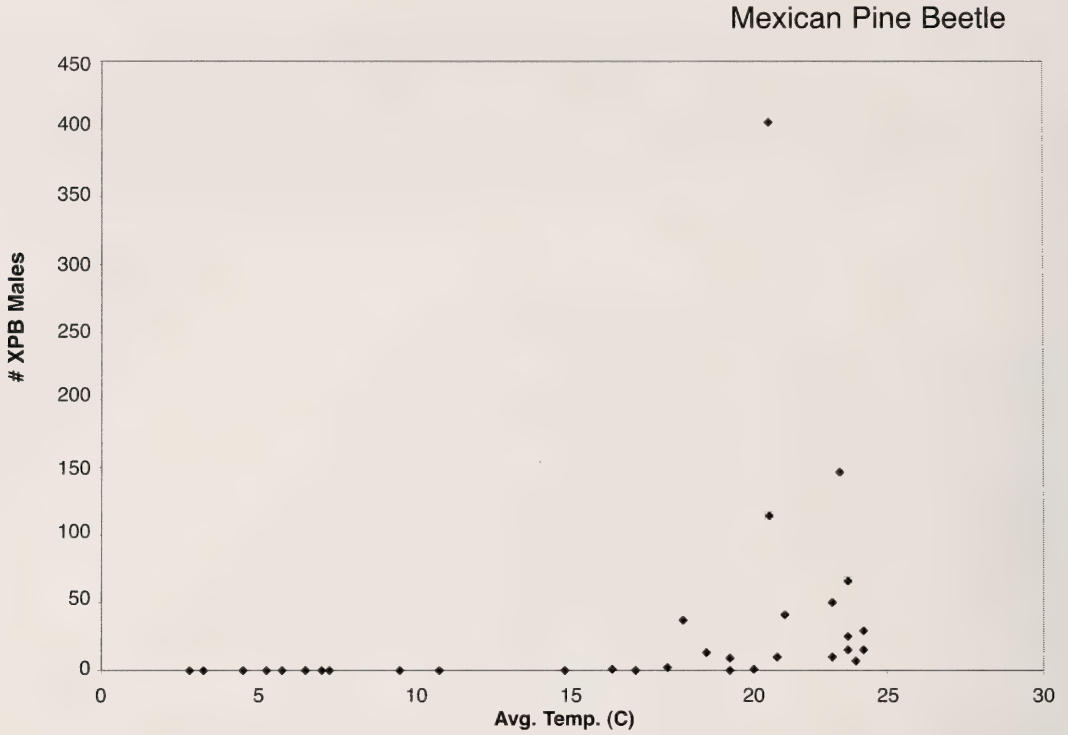


Figure 3. Total number of male *Dendroctonus mexicanus* (XPB) captured at various daily average temperatures in funnel traps at Turkey Creek and Pinery Canyon, Coronado National Forest, Arizona U.S.A. Each data point represents a collection attempt (regardless of whether any beetles were collected).

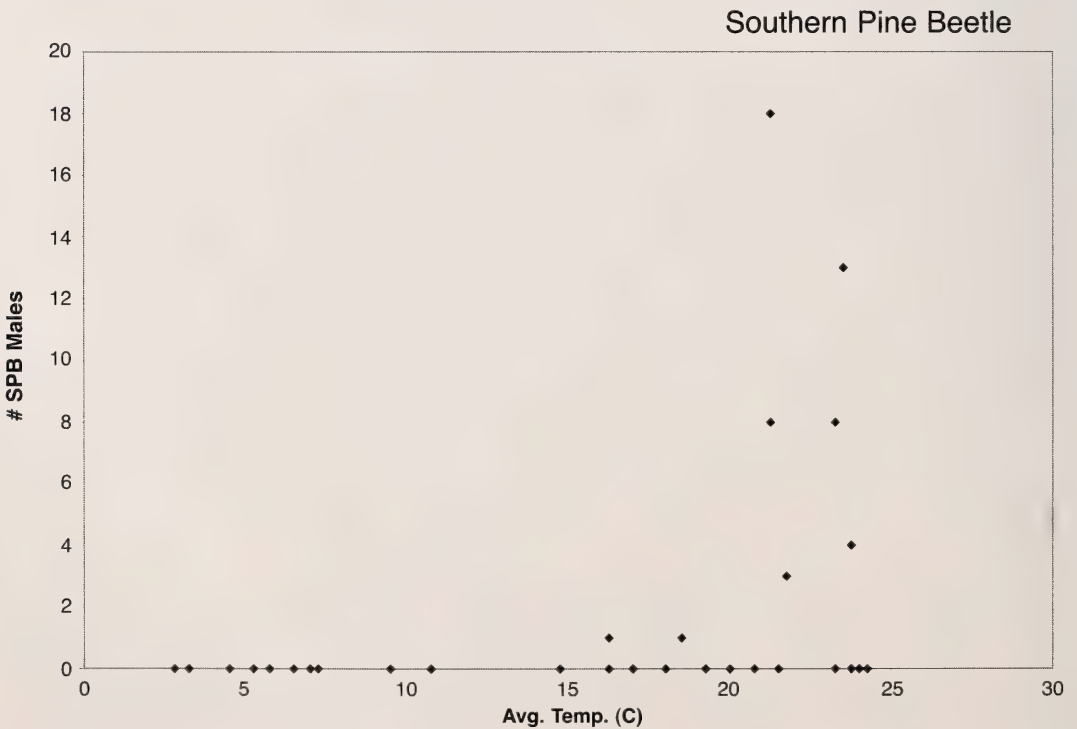


Figure 4. Total number of male *Dendroctonus frontalis* (SPB) captured at various daily average temperatures in funnel traps at Turkey Creek and Pinery Canyon, Coronado National Forest, Arizona U.S.A. Each data point represents a collection attempt (regardless of whether any beetles were collected).

Although it is difficult, given our limited sampling, to estimate the number of generations per year in this area of Arizona, our data indicate far less than the 7-9 generations that this beetle produces per year in the southern U.S. (Payne 1980). Also, SPB numbers declined in mid-Summer but never recovered when cooler weather returned in September. This is in contrast with SPB behavior in the southeastern U.S. where beetles routinely fly during cool weather in the winter (Moser and Thompson 1986). However, ground surveys in October indicated that another possible cause for the decline was that the Pinery Canyon infestation was moribund and producing few beetles.

Examination of 474 SPB and 7,541 XPB males over the course of two years yielded no evidence of seminal rods which were intermediate in appearance (between one or more *Dendroctonus* species) (Fig. 5). This supports similar lack of evidence for hybrid individuals reported by others (Lanier et al., 1988; Zuniga et al., 1995).

Although we used a limited number of traps, and were unable to statistically analyze the data, beetle capture seemed to be more influenced by trap location than by bait type. At Pinery Canyon a WPB pheromone baited trap caught the greatest number of beetles, while at Turkey Creek, a SPB pheromone baited trap caught the most beetles. These results indicate that the baits may have little to do with the numbers caught, and suggest that these two traps may merely have been closer to heavily infested trees. Because the XPB (and SPB) were trapped during warm periods in winter, we speculate that they attack trees during the winter, as the SPB do in the southeastern U.S. (Payne, 1980).

The reasons for the predominance of XPB over SPB at our sites are hard to ascertain. It may be that competitive displacement favored the XPB over the SPB, because the XPB is apparently better adapted to higher elevations (Lanier et al., 1988; Wood, 1982). Regardless, the SPB and the XPB were found infesting the same trees. This confirms previous observations by Zuniga et al. (1995). Although SPB have been reported for this area at least once (Lanier et al., 1988), we suspect that earlier XPB populations may have been overlooked because a reliable technique for separating the two species was not developed until 1988, and because SPB may have been the dominant species at that particular time and place when the collections were made (such as during our September 27, 2000 trapping).

We describe XPB here as a new introduction to the U.S. However it is beyond the scope of this study to determine the degree to which this is a recent introduction. Given the morphological and biological similarities of the XPB and the SPB, it is possible that the two species have been co-occurring in this area for some time. The possibility of a more recent invasion (mediated by climatic changes) or introduction (via log transport), however, cannot be discounted. The mechanisms and spatiotemporal aspects of the occurrence of this insect within the U.S. remain to be determined.

Mexican pine beetle

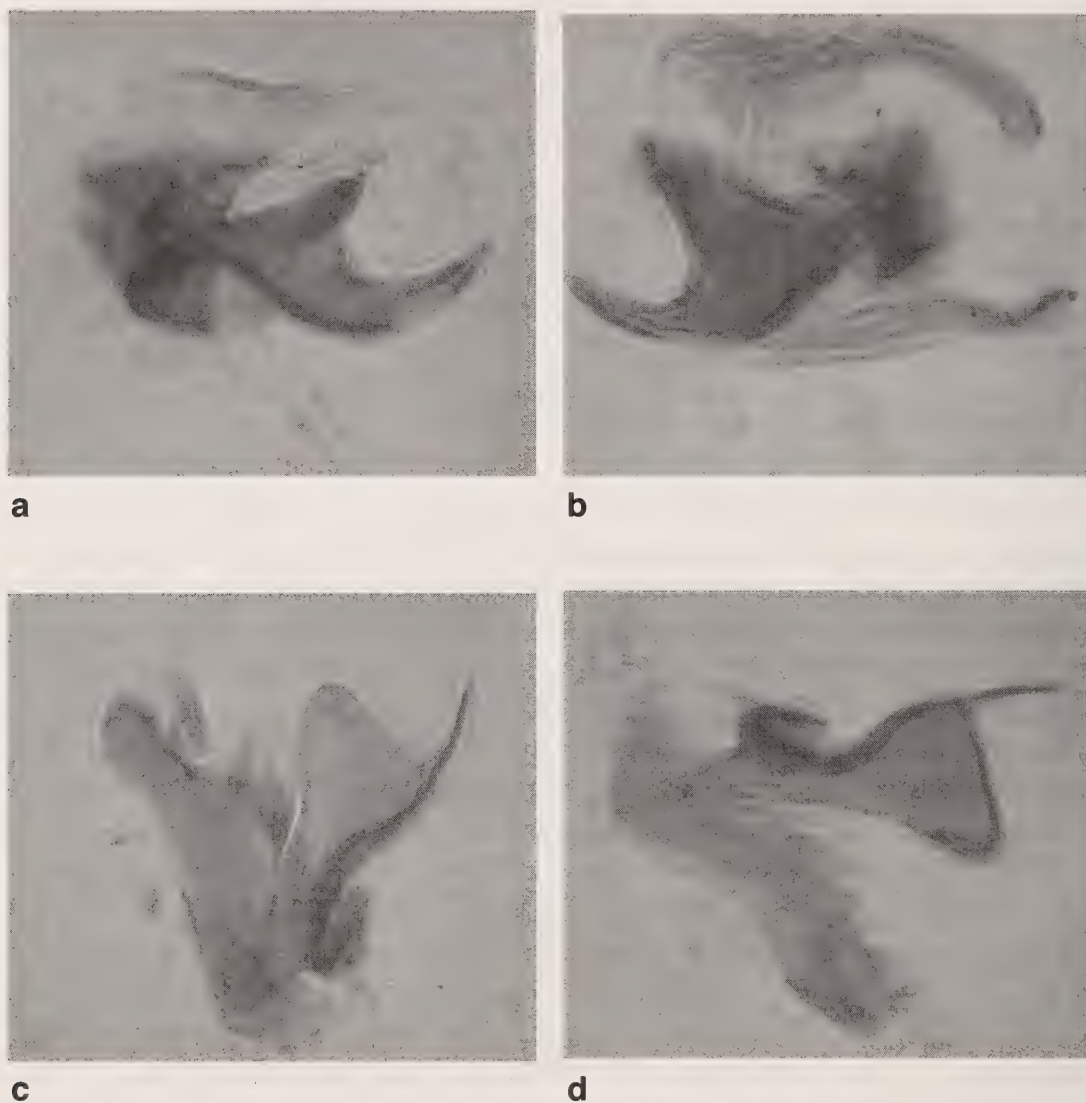


Figure 5. Seminal rods of male XPB (a, b) and SPB (c, d) collected at Turkey Creek and Pinery Canyon, Coronado National Forest, Arizona U.S.A. Photographs by Rich Hofstetter, Northern Arizona University.

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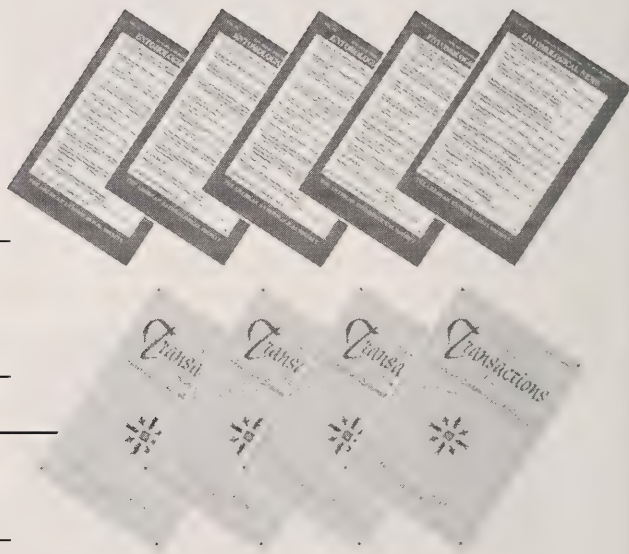
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WINTER PREY PREFERENCE OF *PERLODES MICROCEPHALUS* (PLECTET, 1833) (PLECOPTERA, PERLODIDAE) NYMPHS IN AN APENNINIC CREEK, NORTHWESTERN ITALY¹

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ABSTRACT: The feeding habits of *Perlodes microcephalus* nymphs (Plecoptera, Perlodidae) have been investigated in Caramagna, an Apennine creek located in northwestern Italy. This large species is one of the most representative carnivorous stonefly nymphs in this area, where it is a top-bottom predator in many fishless creeks. Despite its ecological importance, little is known about its trophic ecology. In this study, we examined the gut contents of 35 nymphs during the winter of February 2005. We detected an evident trophic preference for the following taxa: Chironomidae (Diptera) as well as Psychomyidae, Glossosomatidae, *Hyporhyacophila* sp., and other Trichoptera. This preference appears to be independent of the prey's availability in the substratum. Rheostenic taxa, also abundant and widespread in the substratum, were almost absent or seldom found in the diet of *P. microcephalus*. These results suggest that the trophic preferences of *P. microcephalus* are more dependent on prey microhabitat preference than on prey abundance.

KEY WORDS: *Perlodes microcephalus*, Plecoptera, Perlodidae feeding habit, gut contents, northwestern Italy

Monakov (2003) stated that "there is no discipline in hydrobiology that does not require a study of the feeding and nutrition of aquatic animals." Improving our knowledge about feeding behavior and trophic ecology is indispensable to better understand applied and basic elements of stream ecology. For example, increased human influence in aquatic ecosystems lead to changes in feeding and growth of aquatic invertebrates (Broekhuizen et al., 2001), altering composition and structure of benthic communities. Furthermore, studies about feeding habits take an evident interest in an auto-ecological perspective (Elliott, 2003; 2004). In the last decades, there was a growing interest in the trophic ecology of aquatic insects, especially for some groups such as shredders, for their importance in the metabolism of allochthonous organic inputs (Webster and Benfield, 1986), and predators, for their role as top-down control elements in benthic communities (Molles and Pietruszka, 1987; Wipfli and Gregovich, 2002).

In lentic habitats and low flowing waters, large invertebrate predators are mainly represented by the Odonata, Anisoptera and Zygoptera; Coleoptera, Hydroadephaga, as well as by the Hemiptera, Heteroptera. On the other hand, in lotic systems the dominant predator group is represented by the Plecoptera Systellognatha (Allan, 1995). Among the latter, Chloroperlidae, Perlodidae, and Perlidae have carnivorous nymphs of moderate to large size. In adult Perlidae and large Perlodidae, feeding seems to have little or no importance (Tierno de

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Figueroa and Sánchez-Ortega, 1999; Tierno de Figueroa and Fochetti, 2001). In fact, little if any solid food has been found in the gut of some perlid or large perlodids (Tierno de Figueroa and Fochetti, 2001; Fenoglio and Tierno de Figueroa, 2003). Apparently, adults rely on the rich diet of the preimaginal stages (Fenoglio, 2003).

Perlodes microcephalus (Pictet) (Plecoptera: Perlodidae) is a reophilous mesothermal species with a wide distribution in Europe. As all Perlodidae (Merritt and Cummins, 1996), *P. microcephalus* nymphs are known to be active predators. This species is characterised by a very rapid growth rate, reaching 18–28 mm long in only one year (Hynes, 1993). Previous studies highlighted that *P. microcephalus* feeds mostly at night, mainly on Simuliidae, Chironomidae (both Diptera) and on Ephemeroptera (Berthélemy and Lahoud, 1981; Elliott, 2000). In an experiment conducted in laboratory conditions, Elliott (2003) compared predator-prey interactions of four large-sized, carnivorous Plecoptera nymphs: two Perlodidae (*P. microcephalus* Pictet, 1833 and *Isoperla grammatica* Poda, 1761) and two Perlidae (*Dinocras cephalotes* Curtis, 1827 and *Perla bipunctata* Pictet, 1833). Interestingly, *P. microcephalus* was the most active of the four, with a daily mean prey consumption about three times that each of the others, the highest attack rate, and a generally short handling time.

The aim of this study was to investigate the diet of *P. microcephalus* nymphs in an Apenninic creek during the winter, a period in which: a) benthic communities show the greatest diversity and abundance in this area (Fenoglio et al., 2005a) and b) *P. microcephalus* nymphs have a strong energetic need and a high growth rate, before emerging.

METHODS

Between 26–28 February 2005, *P. microcephalus* nymphs were collected in the Caramagna Creek (latitude 44°36' N – longitude 8°32' E; altitude 280 m above sea level; Fig. 1). This lotic system has a good environmental quality, reaching the first class in the Italian Extended Biotic Index (Ghetti, 1997), corresponding to an environment without trace of human-induced alteration. All samplings were carried out in the first hours of the morning, because Systellognatha tend to feed under diminishing light conditions that occur at dusk and dawn (Vaught and Stewart, 1974). We examined 35 specimens, collected in a single uniform 100 m sized riffle. Moreover, using a Surber net (20 x 20 cm; mesh 255 μ m), we collected thirty samples in the same reach to assess the taxa presence and abundance of the natural population of benthic invertebrates. Samples were preserved in 95 percent ethanol (final concentration) in the laboratory. Later, all organisms were counted and identified to the genus, except for Coleoptera, Hydraenidae; Lumbriculidae, and early instars of some Diptera, which were identified to the family level. *Perlodes microcephalus* nymphs were measured (total length, 0.1 mm accuracy) and processed to assess food consumption by means of gut contents

analysis. Guts were removed and the content of the alimentary canal were analysed by the transparency method for slides (Faure's fluid). Identification of prey was based on chitinized body parts, particularly head capsules, mouthparts, and leg fragments.

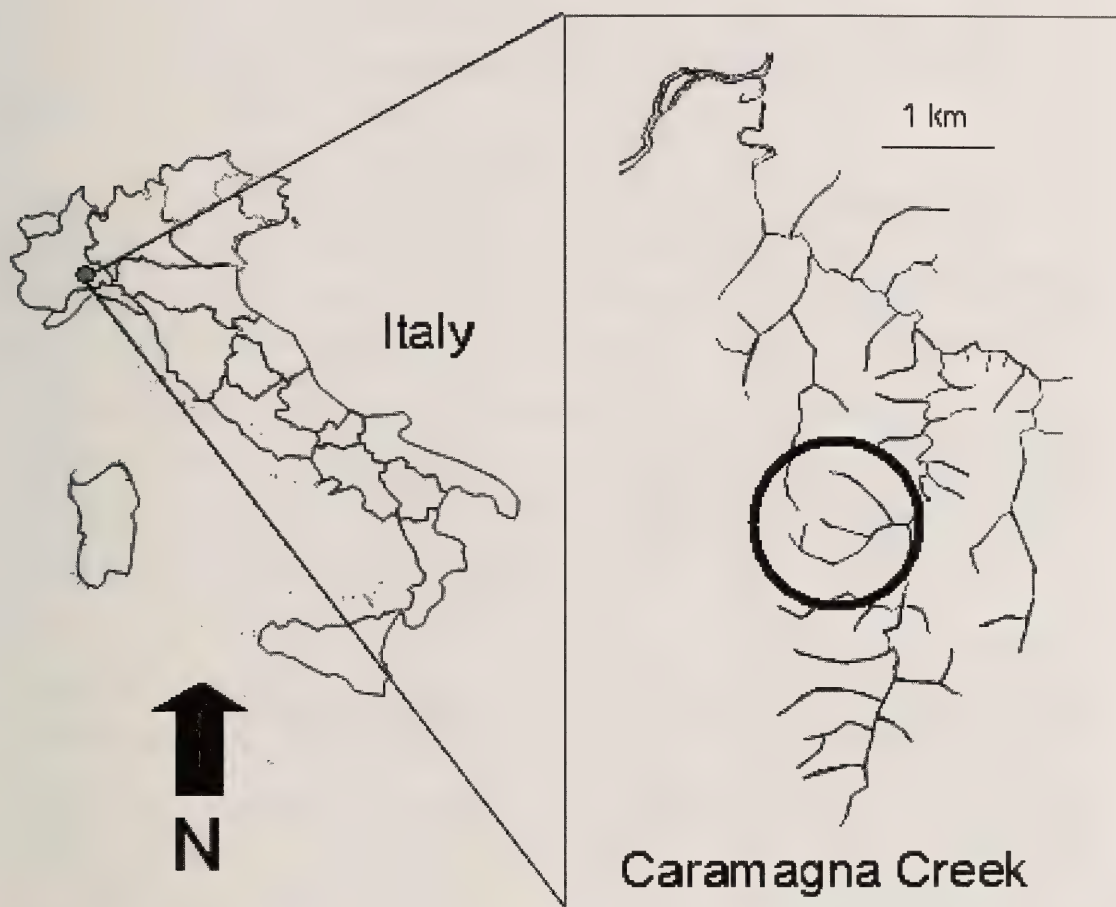


Fig. 1. Caramagna Creek, NW Italy. Circle indicates the sample site.

We also compared gut contents with the natural composition and abundance of macroinvertebrate communities in the riverbed. Feeding preferences were quantified using the Electivity Index by Ivlev (1961),

$$E = (r_i - p_i) / (r_i + p_i).$$

In this formula, r_i = the proportion of ingested species, p_i = the relative abundance in the benthic community, and N = the number of food items. This index ranges from -1 to 1. A value of -1 means total avoidance, 1 indicates preference and 0 indicates indifference.

Table 1. Percent relative abundance (% value in the community) for macroinvertebrates collected in the natural riverbed.

Taxon	FFG	%	Taxon	FFG	%
Arthropoda: Insecta			Limoniidae	P	0.54
Plecoptera			Tabanidae	P	0.15
<i>Isoperla</i> sp.	P	0.73	Hymenoptera		
<i>Capnia bifrons</i>	Sh	0.48	<i>Agriotypus armatus</i>	P	0.04
<i>Leuctra</i> sp.	Sh	0.73	Coleoptera		
<i>Nemoura</i> sp.	Sh	0.30	<i>Helichus substriatus</i>	Sh	0.73
<i>Brachyptera</i> sp.	Sh	21.07	Hydraenidae	Sc	1.17
<i>Perlodes microcephalus</i>	P	0.77	Dytiscidae	P	0.02
Ephemeroptera			Gyrinidae (larvae)	P	0.58
<i>Paraleptophlebia</i> sp.	Cg	0.02	Elminthidae (larvae)	Cg	0.15
<i>Ecdyonurus</i> sp.	Sc	1.36	Elminthidae (adults)	Cg	0.15
<i>Baetis</i> sp.	Cg	7.41	<i>Esolus</i> sp.	Cg	0.06
<i>Caenis</i> sp.	Cg	0.11	Helodidae (larvae)	Sh	0.37
<i>Habrophlebia</i> sp.	Cg	1.23	Hydrophilidae	P	0.02
<i>Habroleptoides</i> sp.	Cg	0.28	Odonata		
<i>Ephemera danica</i>	Cg	0.04	<i>Orthetrum</i> sp.	P	0.09
<i>Centroptilum luteolum</i>	Cg	0.32	<i>Calopteryx</i> sp.	P	0.06
<i>Torleya major</i>	Cg	0.02	<i>Onychogomphus</i> sp.	P	0.06
Trichoptera			Arthropoda: Arachnida:		
<i>Sericostoma pedemontanum</i>	Sh	0.06	Hydracarina	P	0.37
Limnephilidae	Sh	0.71	Mollusca: Gastropoda		
<i>Potamophylax cingulatus</i>	Sh	0.06	<i>Lymnaea peregra</i>	Sc	0.06
Psychomidae	Cg	0.13	Mollusca: Bivalvia		
Goeridae	Cg	0.02	<i>Pisidium</i> sp.	F	0.02
Leptoceridae	Cg	0.06	Platyhelminthes: Turbellaria:		
Glossosomatidae	Sc	0.80	Tricladida		
<i>Hyporhyacophila</i> sp.	P	0.04	<i>Dugesia</i> sp.	P	7.41
<i>Hydropsyche</i> sp.	F	1.04	Nematoda		
<i>Wormaldia</i> sp.	F	0.06	Mermithidae	P	0.02
Beraeidae	Cg	0.02	Annelida		
<i>Odontocerum albicorne</i>	Sh	0.30	Lumbriculidae	Cg	0.26
Heteroptera			Naididae	Cg	0.17
<i>Micronecta</i> sp.	Cg	3.82	<i>Eiseniella tetraedra</i>	Cg	1.60
Diptera			Lumbricidae	Cg	0.82
Stratiomyidae	P	0.06	Tubificidae	Cg	0.13
<i>Atherix</i> sp.	P	0.09	Nematomorpha		
<i>Anopheles</i> sp.	Cg	0.02	<i>Gordius</i> sp.	P	0.09
Simuliidae	F	30.22			
Dixidae	P	0.04			
Chironomidae	var.	10.41			
Ceratopogonidae	P	0.78			
Psychodidae	P	0.09			
Tipulidae	Sh	1.10			

(*) FFG: functional feeding groups (Cg=collectors-gatherers; F=filterers; P=predators; Sc=scrapers; Sh=shredders; var. = various, mainly Cg and P).

To analyze the dimensional shift in food preference, we separately considered gut contents of smaller nymphs (body length < 20.0 mm) and larger nymphs (body length > 20.0 mm). The preference for individual prey taxon was evaluated between the two length classes using indicator species analysis, computed by the INDVAL 2.0 software (Dufrêne, 1998). Indicator species analysis is a randomization-based test that compares the relative abundance and relative frequency of occurrence of taxa to find indicator species assemblages characterizing groups of samples.

RESULTS

In total, 30 Surber samples were collected, including 4629 aquatic invertebrates belonging to 63 taxa. The gut content of 35 *P. microcephalus* nymphs was examined. The list of taxa and their relative abundance are listed in Table 1. The mean abundance of stream benthic community was 3856.7 individuals/m² ± 632.6 SE.

In Table 2, we report the list of taxa found in the *P. microcephalus* guts. The most important prey in the guts were Chironomidae (Diptera): they constituted 43.2 percent of total ingested items, and they were present in the 74.3 percent of examined guts. Other important prey were Trichoptera, particularly Psychomyidae, Glossosomatidae, and Limnephilidae.

Table 2. Indicator values, abundance, and fidelity for prey taxa found in smaller and larger *P. microcephalus* guts.

Species	IndVal	Smaller nymphs	Larger nymphs	P
Glossosomatidae	43.33	4/4	51/9	<0.01
Chironomidae	44.74	122/12	98/14	n.s.
Psychomyidae	27.83	37/8	35/11	n.s.
Plecoptera und.	26.32	0/0	7/5	n.s.
Ephemeroptera und.	5.79	0/0	3/3	n.s.
Trichoptera und.	49.98	41/13	84/15	n.s.
Simuliidae	9.76	6/2	2/2	n.s.
<i>Hyporhyacophila</i> sp.	6.25	1/1	0/0	n.s.
Heptageniidae	12.18	1/1	4/3	n.s.
<i>Brachyptera</i> sp.	15.08	2/1	6/4	n.s.
<i>Baetis</i> sp.	3.39	1/1	1/1	n.s.
Limnephilidae	6.60	1/1	2/2	n.s.

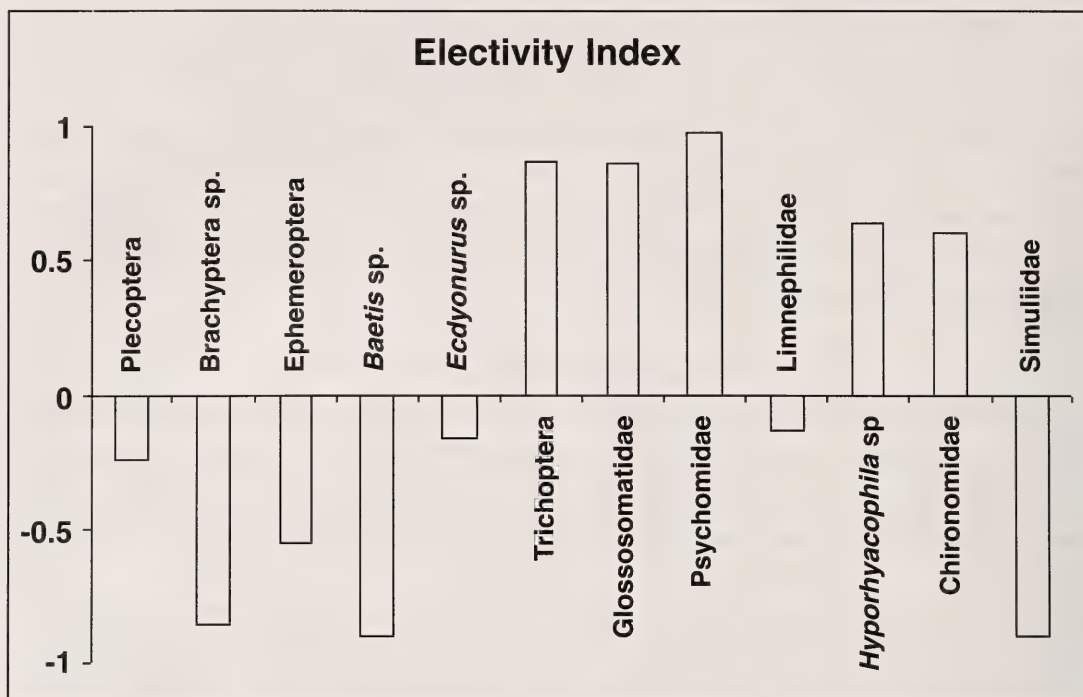


Fig. 2. Electivity index (E^*) for macroinvertebrate taxa in the *P. microcephalus* nymphs diet in the Caramagna Creek.

Comparing gut contents of the two dimensional classes (smaller nymphs, $n=16$; larger nymphs, $n=19$), we detected no significant quantitative difference (i.e.=number of preys consumed; ANOVA $F_{1,33}=0.51$, $P=n.s.$) but interestingly we noticed a significant qualitative difference (i.e.=number of taxa ingested; ANOVA $F_{1,33}=4.95$, $P<0.05$), with larger nymphs feeding on a wider range of preys. In the guts of larger individuals we found 3.7 ± 0.29 (mean $\pm$ SE) prey taxa, while in smaller ones 2.7 ± 0.33 (mean $\pm$ SE). IndVal analysis detected that larger individuals showed a significant preference for Glossosomatidae, considering both number of items and number of guts.

DISCUSSION

Behavioral and ecological studies about stream macroinvertebrates predation mechanisms are attracting a growing interest in the last decades. In field conditions, most studies analyzed prey choice by means of the examination of gut contents (Fuller and Stewart, 1977; Allan, 1995; Peckarsky, 1996). In particular, prey selection is becoming a key element in this context: different studies focused on the reasons why some prey species are captured in preference to others. This could depend by how frequently predators and prey encounter, which is the probability of an attack and the level of the attack success. In an elegant laboratory study Tikkanen et al. (1997) demonstrated that, for a Perlodidae species, encounter rates were poor predictors of the preferences for different prey categories. Frequently encountered preys, such as Ephemeroptera Baetidae, were only rarely ingested, while other more stationary organisms, such as Simuliidae

and Nemouridae, were rarely encountered but when they were, they were captured with high success.

Comparing gut contents with the array of available prey living on and among substrates, we detected some interesting elements. The electivity index showed that some taxa were preferred or avoided independently from their availability in the riverbed. Although some groups were abundant and widespread on the river bottom, they were virtually absent in the diet. Noticeably, rheostenic organisms living in epilithic microhabitats, such as Simuliidae and Heptageniidae were little present, while we detected a strong preference for taxa living among and below substratum elements, such as Chironomidae, Psychomyidae, Glossosomatidae, and others. Our study, according to the results of other studies concerning Systellognatha diet (Siegfried and Knight, 1976; Berthélemy and Lahoud, 1981), confirms that Chironomidae are the most important component in the carnivorous stonefly diet: also if electivity index shows an evident preference for some taxa (e.g.: Psychomyidae) independently from their availability, Chironomidae represent the most common prey item in the guts of *P. microcephalus*. The mean abundance of stream communities agree with the findings of other studies conducted in the same area (Fenoglio et al., 2005b).

Many studies, conducted in the field by analysis of gut contents, revealed a good correlation between what is eaten and what is available (Allan, 1995). Allan and Fleckner (1988) noticed that the rank order of prey taxa in the diet of the large sized *Hesperoperla pacifica* Banks 1900 (Perlidae) is analogous to the prey rank order in the benthos.

Interestingly, our study supports the hypothesis that *P. microcephalus* shows an evident trophic preference, feeding mainly on medium-sized, less mobile organisms, and avoiding taxa inhabiting fast-flowing waters. Our data may also indicate the growth of the trophic spectrum over time, as noticed in other Systellognatha (Femminella and Stewart, 1986) with larger nymphs hunting and consuming a higher number of taxa.

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A KEY TO ADULT NEARCTIC *PASIMACHUS* (*PASIMACHUS*) BONELLI (COLEOPTERA: CARABIDAE: SCARITINI), WITH COMMENTS ON THEIR FUNCTIONAL MOUTHPART MORPHOLOGY¹

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ABSTRACT: A key to adults of the 11 species of *Pasimachus* Bonelli found in the United States and Canada is presented. A generalized plan of their dentition is outlined, including the first report of a labral occlusion of mandibles in the Carabidae, illustrated with scanning electron micrography.

KEY WORDS: Coleoptera Carabidae, *Pasimachus*, adult, functional mouthpart morphology, nearctic, key

Eleven species of *Pasimachus* Bonelli occur in America north of Mexico; only *P. elongatus* LeConte reaches Canada. These predatory beetles are large to very large, their greatest length ranging from 22 to 38 mm, with massive heads and markedly toothed falcate mandibles. They are black, the pronotum and elytra often bordered with metallic blue or violet. In *P. viridans* Leconte only, the borders are vivid green. In specimens with metallic color, some ventral surfaces are also slightly tinted. Their eyes are small and flattened, their foretibia broadened apically and toothed laterally as a consequence of a fossorial lifestyle; all are flightless.

Sexual dimorphism is generally very reduced in the Scaritini, though more-or-less subtle albeit often inconstant differences are present in some species of *Pasimachus*. Male *P. californicus* Chaudoir and *P. punctulatus* Haldeman metatibiae have a dense posterolateral golden pile in their apical half, much sparser in females. Female *P. depressus* (F.) mandibles are obliquely rugostriated whereas those of males are usually entirely smooth. Bänninger's (1950) taxonomic revision is replete with details of male genitalia character states but includes no illustrations; we leave the matter of their taxonomic usefulness to the next reviser, portended by a putative *P. punctulatus* X *P. elongatus* hybrid male from southern Ohio (Scioto County), determined by George E. Ball based on the genital armature. Bänninger (1950) indicated the genitalia of these two species differ significantly but hybridization would seem to belie that.

Old specimens have worn surfaces so mandibular sculpturing is an unreliable character, as for the same reason can be elytral ornamentation with costae, humeral carinae and serial punctures. Colors also can suffer from advanced specimen age and wear; they vary too in intensity across the distributional range of species.

Intraspecific variability and the general paucity of specific character states in this genus have made determinations difficult. Moreover, Bänninger's (1950) key to species in his revision is difficult to use because it suffers from an excess of non-exclusionary detail, the bane of dichotomous taxonomic keys. In spite of much

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detail he failed to make use of some worthwhile characters mentioned by LeConte (1874), who described five of the 11 currently valid species found north of Mexico. Bänninger (1950) in fact states that *Pasimachus* (*s. str.*), containing all these 11 species, is "...poor in sharply defined, constant characters."

The purpose of this article is to present a taxonomic key to species that combines elements from the treatments published by Bänninger (1950) and LeConte (1874) as well as to add distributional information assembled in the catalogue of Bousquet and Laroche (1993). Lindroth (1961) treated only *P. elongatus* (including figures); he too alluded to the intraspecific variability and inconstancy that characterize members of the genus.

We also comment on dentition and report a novel labral occlusion that stops retraction of mandibles in *Pasimachus*, to our knowledge an adaptation that is unique among Carabidae.

METHODS

We studied *Pasimachus* specimens held in the Museum of Biological Diversity (Ohio State University, Columbus), the Cleveland Museum of Natural History, the Cincinnati Museum Center and in private collections. Determinations were made or confirmed using Bänninger (1950) and LeConte (1848, 1874).

Measurements of overall lengths are taken from Bänninger (1950). In reference to the numbering of abdominal sterna (in Key), I note that in Adephaga, sternum II is basalmost, sternum I evidently having been lost from the ancestral coleopteran stock. Thus, with six pregenital sterna (i.e. those exposed when the male is not in copulo, or the female is not ovipositing), the last one is abdominal sternum VII (see e.g. Purrington 2000).

We interpreted dental homologies using Jeannel (1926), Ball (1959), Bell (1960), Goulet (1983), Evans and Forsythe (1985), Acorn and Ball (1991), Davidson and Ball (1998) and Shpeley and Ball (2000).

A Carrington 108 was used to sputter-coat heads and mouthparts with gold/palladium; we obtained micrographs with a Philips XL30 Scanning Electron Microscope at the Ohio State University Microscopy and Imaging Facility in Columbus.

KEY TO THE SPECIES OF *PASIMACHUS* BONELLI OF AMERICA NORTH OF MEXICO

1. One pair each of ambulatorial setae on abdominal sterna IV-VI..... 5
 - No such setae present (except rarely as asymmetrical anomalies) 2
2. Fixed apical mesotibial spine acute, not flattened 3
 - Fixed mesotibial spine flattened, blunter 4
3. Antennomeres 2-4 compressed and sub-carinate; uneven elytral intervals notably convex to apex; large: 26-32 mm *P. marginatus* (F.)

- Antennomeres 2-4 not compressed or sub-carinate; uneven intervals not notably convex; much smaller: 19-22 mm*P. subsulcatus* Say
- 4. Pronotum markedly constricted basally, hind angles right, elytra smooth; very large: 29-35mm*P. strenuus* LeConte
- Pronotum little constricted basally, hind angles obtuse; elytra irregularly dimpled; much smaller: 21-30 mm*P. sublaevis* (Palisot de Beauvois)
- 5. Pronotal and elytral margins vivid metallic green (Arizona only)*P. viridans* LeConte
- Margins black or metallic blue or violet.....6
- 6. Prosternum intercoxal process produced apicad, somewhat conical.....7
- Intercoxal process not so produced apicad, blunter.....8
- 7. Frontal ridge (above antennal insertion) prominent and subangular in front of eye; mandibles in both sexes obtusely rugostriate dorsally, in males very long and thin apicad retinacular teeth *P. punctulatus* Haldeman
- Frontal ridge smoothly rounded, not prominently subangular; male mandibles smooth dorsally, wider and shorter apicad retinacular teeth.....*P. depressus* (F.)
- 8. Elytral intervals 7 and 8 costate, the 8th strong to near apex*P. duplicatus* LeConte
- Intervals 7 (beyond humeral carina) and 8 not noticeable 9
- 9. Humeral carina of 7th interval short; large specimens:22-35 mm*P. californicus* Chaudoir
- Humeral carina long; much smaller: 21-28 mm 10
- 10. Pronotal and elytral borders wide and usually bright metallic blue*P. elongatus* LeConte
- Borders narrow; specimens almost entirely black with a trace of blue near humeral angles (best seen when wetted).....*P. obsoletus* LeConte

SPECIES ACCOUNTS

Distribution information (Bousquet and Laroche 1993) is given using the United States Postal Service two-letter codes for the US states and Canadian provinces.

***Pasimachus californicus* Chaudoir**

Very large (27-38 mm), with *P. strenuus* (known from Florida only) the largest species in genus. Usually somber, often completely black; basal foveae of pronotum little pronounced. Mandibles dorsally quite smooth or not. Male metatibia with dense golden pile along inner distal third.

Distribution: AR, AZ, CO, KS, NM, OK, TX, UT.

***Pasimachus depressus* (F.)**

Length, 24-31 mm; mandibles of male usually completely smooth, somewhat convex dorsally, of females rugostri and flatter.

Distribution: AL, AR, DC, DE, GA, IA, IL, IN, KS, KY, LA, MD, MO, MS, NC, NJ, NY, OH, OK, PA, SC, TN, TX, VA, WI.

***Pasimachus duplicatus* LeConte**

Length, 25-30 mm; outer elytral intervals notably developed, the inner not; very little color.

Distribution: AZ, CO, KS, MO, NM, OK, TX.

***Pasimachus elongatus* LeConte**

Length, 21-28 mm; margins of pronotum and elytra usually bright blue, with wide gutters. Male metatibia with a dense golden pile along inner distal third. Inhabits prairie and grassland (Lindroth 1961).

Distribution: AB, AR, AZ, CO, IA, IL, IN, KS, LA, MB, MI, MN, MO, MT, ND, NE, NM, OH, OK, SD, SK, TX, WI, WY.

***Pasimachus marginatus* (F.)**

Length, 26-32 mm; uneven intervals markedly convex to apex; pronotum little constricted basally. Elytra with pronounced granular isodiametric microsculpture between smoother, shinier costae.

Distribution: AL, FL, GA, CA, MS, NC, SC, TX.

***Pasimachus obsoletus* LeConte**

Length, 22-26 mm; typically colorless, occasionally margins of pronotum and elytra faintly blue or violaceous, best seen wetted. Mandibles often bear a prominent lobe on terebral ridge apicad retinacular teeth. Male metatibiae lack a dense golden pile along inner distal third.

Distribution: AZ, CO, IA, KS, NE, NM, SD, TX, WY.

***Pasimachus punctulatus* Haldeman**

Length, 27-33 mm; usually with bright violet-blue borders. Male mandible typically much longer and thinner apicad retinacular teeth compared with the otherwise similar male *P. depressus*. Mandibles rugostriate dorsally in both sexes. Male metatibiae with a dense golden pile along inner distal third.

Distribution: AL, AR, IL, IN, KY, LA, MO, MS, OH, TN, TX.

***Pasimachus strenuus* LeConte**

Length, 29-35 mm; conspicuously wide, elytral intervals slightly convex, evident; in bulk the equal of *P. californicus*.

Distribution: FL.

***Pasimachus sublaevis* (Palisot de Beauvois)**

Length, 21-30 mm; pronotum relatively unconstricted basally, hind corners obtuse, elytral intervals evident and convex, elytra somewhat irregularly dimpled as shown by LeConte (1848) on four habitus figures.

Distribution: AL, DC, FL, GA, IA, IL, IN, MA, MS, NC, NJ, NY, SC, TN, VA.

Remarks: Ciegler (2000) illustrates the apically rounded or blunted fixed mesotibial spine of this species. We have seen a specimen from central Iowa (Hamilton County, Webster City, 15.VIII.2003, collector Crystal Pruin) in the Hoslett Museum of Natural History, Luther College, Decorah (new record for Iowa and the first from west of the Mississippi River).

***Pasimachus subsulcatus* Say**

Length, 19-22 mm; this species is the smallest of the sub-genus. Pronotum base markedly emarginate above scutellum. Lateral pronotal margin just above hind angles slightly irregular, crenulate.

Distribution: AL, FL, GA, LA, SC.

Remarks: Nichols (1988) included *P. floridanus* Casey in his key to West Indian (including Florida) *Pasimachus* (*s. str.*) but in text he hedged, stating, "Further study is needed to determine ... whether it is a taxon worthy of distinction from *P. subsulcatus* Say." We concur.

***Pasimachus viridans* LeConte**

Length, 24-29 mm; when the typical vivid metallic green of the borders is evident, this species of restricted distribution (in the United States) is unique.

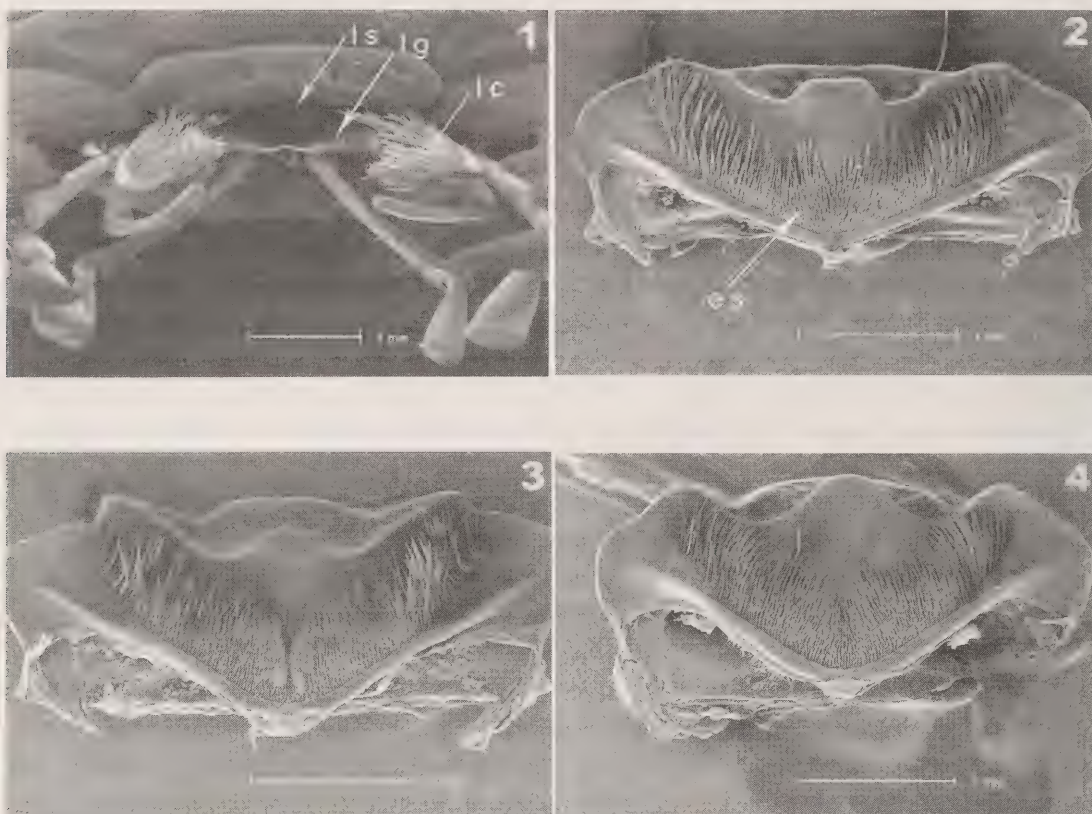
Distribution: AZ.

DISCUSSION

Pasimachus (*s. str.*) mandibles are evenly arcuate, usually obliquely rugostriate dorsally, ventrally and in the scrobes of both sexes. Each bears a large carnassial retinacular tooth positioned well in front of the short transversely rectangular labrum when the mandibles are open (Fig. 1). These teeth are unlike the quadricuspid molariform teeth of *Scarites* that perhaps represent a complex of terebral and retinacular teeth. The left mandible bears a bicuspid retinacular tooth (Figs. 6, 8), the right a unicuspid (Figs. 5, 7). As the mandibles close, these teeth slide past each other, the left over the right. Premolars and molars are not present as such, thus only a shearing mandibular occlusion occurs, involving these teeth. Wear facets can develop on the ventral surface of the left retinacular tooth, analogous to vertebrate thegosis (Every and Kühne 1971) that maintains cutting edges as in scissors (self-sharpening) of the canines of male *Hippopotamus* and *Sus*. Ciegler (2000) figures the head of *P. punctulatus* with a left unicuspid tooth and a right bicuspid, an anomalous condition (that we have never seen) or an error.

The prominent teeth on each mandible are likely retinacular, given that mandibles of most carabid larvae feature a large retinaculum. Although we did not investigate mandibles in Carenini adults, John F. Lawrence (personal communication) doubts this Australian tribe is closely related to the Pasimachina, as carenine larvae differ drastically and probably can not shed much light on mandibular homologies among Scaritinae.

The robust transverse labrum of *Pasimachus* (*s. str.*) arrests mandible retraction by intercepting the single cusp of the right mandible tooth and the proximal cusp of the left mandible bicuspid tooth in a transverse, forward opening sulcus subtended ventrally by a prominent median gibbosity, or transverse rounded ledge (Figs. 1 - 4). This ledge, along with the upper central lobe of the labrum, defines the well developed transverse sulcus that engages and stops the mandibles. Although usually not visible from directly above, the labral sulcus can be seen when the head is held at about 30 percent inclination if the mandibles are somewhat opened (Fig. 1). When the mandibles are more-or-less completely retracted and the closed retinacular teeth obstruct the view from above, this

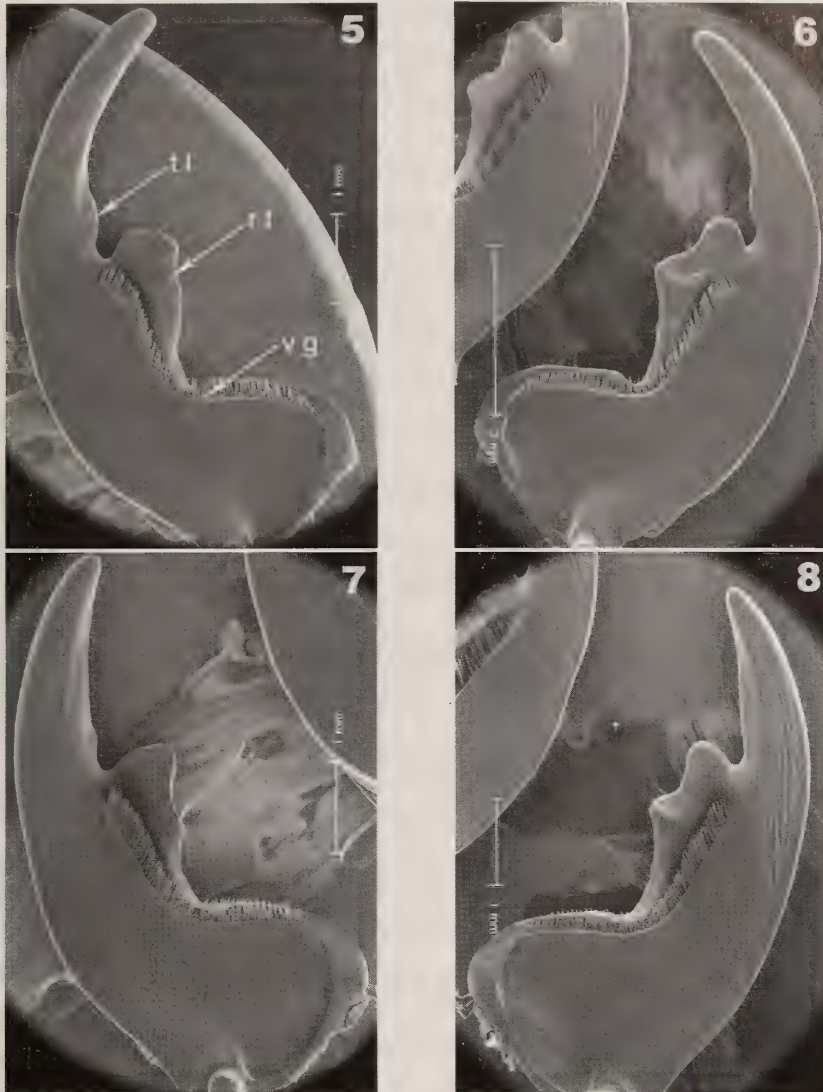


Figures 1-4. 1: SEM of male *Pasimachus punctulatus* head from above, showing position of the labral sulcus; 2: Labrum (ventral view) of male *P. punctulatus*; 3: Labrum (ventral view) of male *P. strenuus*; 4: Labrum (ventral view) of male *P. californicus*; ls - labral sulcus, lg - ligula, lc - lacinia, es - epipharyngeal setae.

sulcus usually can be seen from below, between the broad ligula and the epipharyngeal surface of the labrum. We interpret the shortness and thickness of the very stout labrum, along with its typical markedly developed dorsal corrugation, as providing the necessary mechanical strength to halt movement of such powerful mandibles. A testament to the forces at play is frequent chipping and wear of the retinacular teeth and occasional breakage of part of the lower labral sulcus ridge.

The labral sulcus is restricted to the sub-genus *Pasimachus*. It does not occur in species of *Emydopterus* Lacordaire, which sub-genus is not represented north of Mexico. Kohlman (1993) mentions, without elaboration, a keel on the anterior labrum of *Pasimachus* (*s. str.*); he does not ascribe any function to it. Nichols (1988) makes no mention of it.

Forsythe (1982) and Evans and Forsythe (1985) outlined functional mouthpart morphology of several Carabidae adults, noting that in Scaritini the labrum is not fused to the clypeus as it is in Carabini, Cychrini and Cicindelini, groups they



Figures 5-8. 5 and 6: *Pasimachus punctulatus* right and left mandibles, respectively (male, ventral view); 7 and 8: *P. strenuus* right and left mandibles, respectively (male, ventral view); rt - retinacular tooth, vg - ventral groove, tl - terebral lobe.

considered fluid feeders with pre-oral digestion of prey. As in other Scaritini, the labrum of *Pasimachus* is not fused to the clypeus but is linked to it by a thick, slightly flexible membrane. Lacking molariform teeth, however, they may be more specialized as fluid feeders than *Scarites*, which do have such teeth.

On some specimens of several species a lobe, variously developed, exists on the terebral ridge of both mandibles apicad the large retinacular teeth. It is likely a terebral tooth. Usually it is better developed on the right mandible. It is inconstantly manifested within species, but is well developed in some *P. viridans*, *P. obsoletus*, *P. elongatus* and *P. duplicatus*, moderately so in most *P. depressus*, *P. californicus*, *P. punctulatus* (Figs. 5, 6) and *P. sublaevis*. We have not seen it in *P. marginatus*.

Jeannel (1926) generated a terminology for mandibular structures of certain Trechinae, essentially followed by Ball (1959) for *Diplocheila* (Licinini). Later, Acorn and Ball (1990) presented a detailed analysis of mandibular structural homologies, accompanied by many illustrations, that gives an insight into the range of such features present among Adephaga and other basal Coleoptera. Bell (1960) figured labeled structures of *Chlaenius* (Chlaeniini) mandibles, Goulet (1983) of *Elaphrus* (Elaphrini) and Davidson and Ball (1998) presented mandibular details of *Rawlinsius papillatus*, the remarkable Mexican Broscini they described. Shpeley and Ball (2000) interpreted the hyper-developed labrum and enlarged ligula of *Eucheila* (*s. str.*) (Lebiini: Pericalina) and extended mandibular terebrae, with other occlusal structures reduced, as indicating a change toward fluid feeding.

Our interpretation of structural homologies may not entirely conform to these earlier schemes since the mandibular attributes of *Pasimachus* (and other Scariini) have not been detailed in the literature and differ considerably from these other groups.

We suggest that a labral occlusion with mandibles in *Pasimachus* (*s. str.*) points to a somewhat different mode of feeding between the two *Pasimachus* subgenera. From comments by Cress and Lawson (1971), who conducted detailed feeding trials of *P. elongatus* in the laboratory, it seems that pre-oral digestion is important. Both adults and larvae were seen to carry wounded prey aloft in the mandibles until resistance ceased, and these authors concluded, from prey remains, that their diet was completely liquid. We cite a dense setal brush on the laciniae (Fig. 1), the very broad ligula (Fig. 1), extensive epipharyngeal setae on the ventral labrum (Figs. 2-4), and the long setate ventral groove on the mandibles (Figs. 5-8) as likely adaptations to fluid feeding. We infer that the engagement of the retinacular teeth with the labrum, and the marked width of the ligula results in an efficient suctorial apparatus for ingestion of fluids, analogous to fluid feeding adaptations in *Eucheila* (*s. str.*) that Shpeley and Ball (2000) mention. The lack of a molariform area at the base of the mandible may also point to fluid feeding. Evans and Forsythe (1985) and Forsythe (1982) outline in detail the structural adaptations for a fluid diet in *Carabus* and *Cychrus*.

We hope that this limited morphological study, along with a streamlined taxonomic key, will generate a closer ecofunctional analysis of this remarkable group of beetles.

ACKNOWLEDGMENTS

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early draft. We especially thank an anonymous reviewer for providing a particularly perspicacious critique of our manuscript. Senior Electron Microscopist Kathy Wolken of the Ohio State University Campus Microscopy and Imaging Facility prepared the scanning electron micrographs. Special thanks to Barb Shardy for help with computer software and to Dave Horn for his continued generous support.

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SARAH KIRK RECEIVES THE 2005 AMERICAN ENTOMOLOGICAL SOCIETY'S CALVERT AWARD

In 1987, the American Entomological Society initiated the Calvert Award to be presented to a young person who has demonstrated outstanding accomplishments in insect-related study. The Award is named in honor of Dr. Philip P. Calvert who joined the Society as a teenager, later became its president, and was a member for 74 years. As Professor of Biology at the University of Pennsylvania and an Associate of the Academy of Natural Sciences of Philadelphia, Dr. Calvert played an important role in stimulating an interest in insects among young people.

This year, the nineteenth Calvert Award was presented to Ms. Sarah Kirk, from West Chester, Pennsylvania, a ninth grade student at Unionville High School in Kennett Square. Her project, entitled "Host Specificity of Insect Infesting Parasitoid Wasps," was selected from among about 20 insect-related science projects presented at the annual Delaware Valley Science Fairs held April 6, 2005, at the Expo Center in Fort Washington, Pennsylvania.

Several other students received recognition for their insect-related science projects. These included Ms. Samantha Neugebauer, an eleventh grade student from Jenkintown (Pennsylvania) whose project, "Will my ants yield to a magnetic field?", was first runner-up. Second runner-up went to tenth-grader Mr. Daniel Zinshteyn of Philadelphia for his project, "An investigation of organic pesticides on stored product pests." In addition, there were two honorable mentions to eight grade students: June Maloney from Monroeville (New Jersey) who studied "How will altering the diet of a tobacco budworm affect its maturation?", and Ms. Stacy Candelario from Bethlehem (Pennsylvania) who studied "Navigational skills with ants."

All students were honored at the Calvert Award ceremonies held on April 27, 2005, at the Academy of Natural Sciences in Philadelphia. Dr. Susan Whitney King, President of the American Entomological Society, presented them with certificates of accomplishment and memberships in the American Entomological Society and the Young Entomologists' Society.

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SCIENTIFIC NOTE

**MOLECULAR GENETIC EVIDENCE FOR
A NOVEL BACTERIAL ENDOSYMBIONT OF
ICOSTA AMERICANA (DIPTERA: HIPPOBOSCIDAE)¹**Will K. Reeves²

Adult Hippoboscidae feed exclusively on the blood of their mammalian and avian hosts. Blood is nutritionally restrictive, because it is deficient in some vitamins. Symbiotic microorganisms presumably play a role in synthesizing vitamins for their hosts (e.g. Akman et al., 2001). The bacterial symbionts of Hippoboscidae are generally restricted to the digestive tract, milk glands, and reproductive system (Aschner, 1946; Bequaert, 1953). These symbionts include rickettsial agents (Lloyd, 2002), but the diversity and phylogenetic relationships of these endosymbionts are poorly defined. Endosymbionts might be targets for novel insect or pathogen control techniques if the bacteria can be killed with antibiotics or modified by genetic engineering (e.g. Askoy, 2003). Hippoboscidae are important vectors of bacteria, filarial nematodes, protozoa, and viruses to wild and domestic animals (Lloyd, 2002). Ancillary evidence implicates *Lipoptena* sp. as vectors of a bacterium, *Bartonella schoenbuchensis*, which causes deer ked dermatitis to humans (Dehio et al., 2004).

Three female *Icosta americana* Leach (Diptera: Hippoboscidae) were collected in Clemson (Pickens County, South Carolina, U.S.A.), from a Cooper's Hawk (Falconiformes), *Accipiter cooperi* (Bonaparte, 1828) by A. Eversole on October 1, 2004. DNA was extracted from two of the flies by freezing them in liquid nitrogen and crushing them with a sterile Teflon pestle. Total DNA was extracted from the pulverized remains with an IsoQuick Nucleic Acid Extraction Kit (ORCA Research Inc., Bothell, Washington, U.S.A.) and resuspended in DNase-free water. The extract was screened for the DNA of bacterial symbionts by polymerase chain reaction (PCR) amplification of the 16s rDNA gene using the primers Rick16sF1 (GTATGCTTAACACATGCAAGTCGAAC) and Rick16sR4 (TCCGCGATTACTAGCGATTCC) to amplify a fragment of the 16s rDNA gene. These primers align to the 165620 to 165643 and 166911 to 166929 loci of the *Coxiella burnetii* genome and were designed to amplify DNA from both pathogenic and symbiotic bacteria. Each PCR tube contained 12.5 µl of Taq PCR Master Mix Kit (Qiagen, Valencia, California, U.S.A.), 7.5 µl of nuclease free water, 1.25 µl of each primer, and 2.5 µl of DNA extract in water. Positive and negative controls were used and consisted of genomic DNA extracts of *Coxiella burnetii*, *Rickettsia rickettsii* or distilled water. The PCR amplification cycle used

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with the Rick16sF1 and Rick16sR4 primers consisted of an initial DNA denaturation at 95°C for 5 minutes; followed by 45 consecutive cycles of 1 min denaturation at 95°C, primer annealing at 55°C for 1 min, extension at 72°C for 2 min and a final 10 min extension at 72°C. All stock PCR and sequencing primers were initially at concentrations of 20 µM; 45 amplification cycles were used because some endosymbionts are present in low copy numbers ranging from 20-100 per arthropod. PCR products were separated by 2 percent agarose gel electrophoresis and visualized under ultraviolet light with ethidium bromide. Products were purified with a QIAquick PCR Purification Kit (Qiagen, Valencia, California). Duplicate sequencing reactions were performed with a BigDye Terminator v3.1 Cycle Sequencing Kit (Applied Biosystems, Foster City, California) using both forward and reverse PCR primers, and excess dye was removed with a DyeEx 2.0 column (Qiagen, Valencia, California). Sequences were determined using an ABI 3100 capillary sequencer (Applied Biosystems, Foster City, CA). Primers sequences were removed and sequences were assembled with Seqmerge (Accelrys, San Diego, California) and compared to those in GenBank using the BLAST 2.0 program (NCBI, Bethesda, Maryland).

An 801 bp amplicon was sequenced from a bacterial agent in *I. americana* (GenBank® accession number AY843210). The BLAST search indicated that this amplicon was 97 percent similar to 16s rDNA gene amplicons from unnamed symbionts of *Cimex lectularius* Linnaeus (Hemiptera: Cimicidae) (GenBank® accession number U65654) and *Euscelidius variegatus* Kirschbaum (Hemiptera: Cicadellidae) (GenBank® accession number Z14096). Hypsa and Aksoy (1997) placed these endosymbionts as sister taxa within a clade of the Gamma-subdivision of the Proteobacteria that included *Buchnera aphidicola*, a symbiont of *Acyrtosiphon pisum* (Harris) (Hemiptera: Aphididae), *Serratia marcesens*, a free living opportunistic pathogen, and *Yersinia* spp. including the causative agent of bubonic plague. The similarity between amplicons from the agent in *I. americana* to the endosymbionts of other insects implies that this bacterium could be symbiotic. Symbiotic bacteria with similarities to those of either *C. lectularius* or *E. variegatus* in a blood feeding dipteran have not been reported and similar bacteria might be discovered in other species of Hippoboscidae. Further study could elucidate the relationships of these bacteria to the endosymbionts of other economically important arthropods as well as reveal additional complexities in the life history of these microbes and their hosts.

A voucher specimen of *I. americana* was deposited in the Clemson University Arthropod Collection.

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SCIENTIFIC NOTE

**FIRST RECORD OF *HAEMAPHYSALIS*
LEPORISPALUSTRIS (ACARI: IXODIDAE) ON
LEPUS EUROPAEUS (LAGOMORPHA: LEPORIDAE),
AN INTRODUCED HOST INTO THE NEW WORLD¹**

Darci M. Barros-Battesti² and Marcelo B. Labruna³

The rabbit tick, *Haemaphysalis leporispalustris* (Packard, 1869), is endemic to the New World, where it is possibly the tick with the largest natural distribution, with records from Alaska to Argentina (Guglielmone et al., 2003). Several New World species of rabbits (*Sylvilagus* spp) and hares (*Lepus* spp) have been reported as the main hosts for *H. leporispalustris* (Aragão, 1936; Bishopp and Trembley, 1945; Jones et al., 1972). In Brazil and Argentina, the wild rabbit *Sylvilagus brasiliensis* is the only lagomorph species native to this country, and also the only primary host reported for *H. leporispalustris* (Boero, 1957; Labruna et al., 2000).

At the end of the 19th century, the European hare (*Lepus europaeus*) was introduced in Argentina and Chile through the importation from Germany (Grigera and Rapoport, 1983). Since then, natural populations of *L. europaeus* have expanded to the South American continent upwards. Currently, wild populations of this hare are reported to occur in Argentina, Chile, Uruguay, Paraguay, Bolivia and Brazil (Grigera and Rapoport, 1983). In this last country, hares have been reported from the south to as north as Minas Gerais State (www.instituto-harus.org.br). In many areas, hares cause considerable economic losses to agriculture. It has been reported that *L. europaeus* replaced the native wild rabbit (*S. brasiliensis*) in the Province of Formosa, Argentina (Grigera and Rapoport, 1983). Even though, it is of our knowledge that the only report of ticks infesting *L. europaeus* in South America is *Boophilus microplus* in Argentina (Ivancovich and Luciani, 1992).

On October 9, 2004, an adult male of *L. europaeus* weighing 3 Kg was caught in the Jaguará Park at São Paulo Municipality (23°40'S, 45°44'W), state of São Paulo, Brazil. The hare had a broken leg (it was probably hit by a car) and was rescued by a veterinarian that was visiting the area. Two ticks were collected from this hare, being one male and one female of *H. leporispalustris*. The ticks have been deposited in the Instituto Butantan Acari Collection (IBSP) under the accession number IBSP-9142.

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This is the first report of *H. leporispalustris* on the European hare. Although this hare is currently widespread in southern South America, there has been no systematic study of ticks infesting this particular host species. As *H. leporispalustris* is a common parasite of Nearctic hares (*Lepus* spp) in North America, it is quite possible that *L. europaeus* become an important host for *H. leporispalustris* in South America. This topic is of major public health significance, since *H. leporispalustris* is incriminated to maintain an enzootic cycle of *Rickettsia rickettsii*, the causative agent of a highly lethal spotted fever in the New World, including Brazil, Costa Rica, Colombia, Mexico, and the United States (Dias and Martins, 1939; Fuentes et al., 1985; McDade and Newhouse, 1986). For instance, spotted fever caused by *R. rickettsii* has increased in Brazil recently, what has turned it a nationally notifiable disease since 2002. In the state of São Paulo, there were 76 laboratory-confirmed cases from 1985 to 2002, with a lethality of 47.6 percent (Silva and Galvão 2004).

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SCIENTIFIC NOTE

**SIGNIFICANT RANGE EXTENSIONS FOR
KANGELLA AND *VIETNAMELLA*
(EPHEMEROPTERA: EPHEMERELLIDAE,
VIETNAMELLIDAE)¹**

Luke M. Jacobus,² W. P. McCafferty,² and Robert W. Sites³

Recent emphasis on the Oriental Ephemeroptera fauna (e.g., Sites et al. 2001, Soldán 2001) has expanded the known geographic range of several families and genera, especially in China and Thailand (e.g., Zhou and Zheng 2001; Parnrong et al. 2002; Zhou et al. 2003, 2004; Zhou 2004). Our examination of extensive Ephemeroptera collections from Thailand has yielded new records and significant range extensions for certain pannote mayflies (McCafferty and Wang 2000), reported below. At this time, our material examined is deposited in the Enns Entomology Museum, Columbia, Missouri, USA; however, some specimens will be deposited in Thailand with the National Science Museum, Pathum Thani; and the Royal Forestry Department, Bangkok. Images of collecting localities ("L" numbers) in Thailand are available online, via a locality image database at the Enns Entomology Museum website.

***Kangella brocha* (Kang and Yang).** The monospecific genus *Kangella* Sartori (2004) has been reported only from Taiwan (Kang and Yang 1995, Soldán 2001), and it represents the single Ephemeroptera genus that has been considered endemic to the island (Soldán and Yang 2003). Our new records, however, indicate that the genus has a broader range of distribution and that no mayfly genera are endemic to Taiwan. Our specific identification was verified by comparison to a paratype of *K. brocha*. *Kangella* larvae are differentiated from other Ephemerellidae by having the length of the antennae greater than one-half the body length, the mandibles greatly elongate, and the labrum elongate and trapezoidal. The alate stages are unknown.

We examined the following material: CHINA, **Taiwan**, Hsinchu Hsien, Wufeng, 24-X-1991, SC Kang, HC Chang, one larva (paratype). THAILAND, **Kampaeng Phet Prov.**, Khlong Lan National Park, Khlong Nam Lai Waterfall, 16°11'N, 99°15'E, 751m elev., 6-IV-2003, L-448, Sites, Vitheepradit, Prommi, Setaphan, three larvae; Mae Wong National Park, Kaeng Pa Nang Koi, 16°02'N, 99°13'E, 290m elev., 7-IV-2003, L-451, Sites, Vitheepradit, Prommi, Setaphan, two larvae.

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***Vietnamella* spp.** The genus *Vietnamella* Tshernova (1972) has been reported from Vietnam and southern China (reviewed by McCafferty and Wang 1997, Soldán 2001). The record from Prachuap Khiri Kan Province listed below extends the range of this genus south onto the Malay peninsula. *Vietnamella* larvae are distinguished easily from other pannote mayflies (McCafferty and Wang 2000) by having long cephalic horns, enlarged forefemora with a serrate ventral (leading) margin, and gills on abdominal segments 1–7. Alate stages are identifiable by cephalic horn vestiges, wing venation, and the structure of the male genitalia (You and Su 1987, Wang and McCafferty 1995). We have not assigned specific identifications to the specimens we examined because the taxonomy of species in this genus remains somewhat dubious, as indicated and discussed by McCafferty and Wang (1997) and Soldán (2001).

We examined the following material: THAILAND, **Chiang Rai Prov.**, stream from Khun Kon waterfall, 19°51'N, 99°39'E, 524m elev., 19-IV-2003, L-466, Vitheepradit, Prommi, Setaphan, one larva; **Prachuap Khiri Khan Prov.**, Amphur Kui Buri Forest Plantation Station, 12°04'N, 99°37'E, 117m elev., 17-V-2002, L-540, Vitheepradit, Ferro, one larva; **Nan Prov.**, Amphur Bo Kluea, Ban Bo Kluea Tai, Nam Mang, gravel, 19°09'N, 101°09'E, 663m elev., 22-IV-2003, L-476, Vitheepradit, Prommi, Setaphan, two larvae.

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Michel Sartori (Musée cantonal de zoologie, Lausanne, Switzerland) loaned type material for study. Chaweewan Hutacharern (Royal Forestry Department), Jariya Chanpaisaeng (Kasetsart University), and Pornpip Chantaramongkol (Chiang Mai University) kindly assisted with obtaining permission from the National Research Council Thailand and Royal Forestry Department to make these collections. Akekawat Vitheepradit, Michael Ferro (University of Missouri), Taeng-On Prommi (Prince of Songkla University), Penkhae Thamsenanupap (Chiang Mai University), and Kriengkrai Setaphan (Naresuan University) assisted with fieldwork. Support for RWS was provided in part by NSF project number DEB-0103144 and by MU project number PSSSL0232. This material is based, in part, upon work supported under a National Science Foundation Graduate Research Fellowship to LMJ.

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SCIENTIFIC NOTE

FIRST ATLANTIC COASTAL PLAIN OCCURRENCE OF *GOMPHUS FRATERNUS* SAY (ODONATA: GOMPHIDAE)¹Christopher M. Heckscher² and Harold B. White, III³

On May 15, 2002, CMH collected an unidentified gomphid within the wooded north shore of Broad Creek, Sussex County, Delaware, at approximately 38° 34'N, 75° 38'W. Broad Creek is entirely within the Middle-Atlantic Outer Coastal Plain physiographic province. The specimen was examined by HBW and others and was eventually identified as *Gomphus fraternus* Say. A return visit to the site on May 13, 2004, revealed numerous adults at three disjunct sites east of Phillips Landing, Nanticoke Wildlife Management Area. All sites were on the north side of the outer bends of the meandering river.

Gomphus fraternus ranges from Manitoba to New Brunswick and south to North Carolina and Tennessee (Donnelly, 2004) with its center of distribution in the Midwest. It is considered common in Indiana (Curry, 2001); however, east of the Appalachians, it is rare and local. The species occurs in large lakes or in middle to large-sized rivers with moderate- to rapid-flow (Curry, 2001). Broad Creek is a moderate-sized tidal freshwater tributary of the Nanticoke River within the Chesapeake Bay watershed. Of note, the sites where *G. fraternus* were found maintain firm gravel substrate in an otherwise mud-bottomed river system. A shoreline gravel bar is evident at one of the sites. In the Great Lakes, *G. fraternus* has also been associated with gravel bars (Kennedy, 1922). A firm or sandy substrate has been identified at other locations where this species occurs, such as the Connecticut River in Massachusetts and Connecticut (D. Wagner, pers. comm.).

This occurrence is significant in that it represents the first confirmed populations of *G. fraternus* on the Outer Coastal Plain physiographic province and extends the range of this species eastward to the central Delmarva Peninsula (Delaware and eastern portions of Maryland and Virginia, U.S.A.). Our specimens also represent the first Delmarva Peninsula record and, consequently, a Delaware state record. The closest known population of *G. fraternus* is in the Potomac River on the Middle Atlantic Piedmont physiographic province in Maryland and Virginia, approximately 130 km west of Broad Creek (R. Orr, pers. comm.). Finally, the Broad Creek site and lower Connecticut River populations (D. Wagner, pers. comm.) are distinctive for *G. fraternus* in that both are tidal

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(freshwater) habitats. Voucher specimens have been placed in the Delaware Natural Heritage Program collection and the private collection of HBW.

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DISTRIBUTION OF THE 2004 EMERGENCE OF SEVENTEEN-YEAR PERIODICAL CICADAS (HEMIPTERA: CICADIDAE: *MAGICICADA* SPP., BROOD X) IN PENNSYLVANIA, U.S.A.¹

M. J. Edwards,² A. E. Faivre,³ R. C. Crist III,² M. I. Sitvarin,² and J. Zyla⁴

ABSTRACT: The distribution of brood X seventeen-year periodical cicadas (Hemiptera: Cicadidae: *Magicicada* spp.) in Pennsylvania was surveyed during the early summer of 2004. Field observations, surveys by telephone and e-mail and responses to cicada websites generated a total of 575 georeferenced data coordinates that represent 284 positive periodical cicada sightings and 291 reports confirming the absence of periodical cicadas. Data coordinates were mapped using Geographical Information Systems software. Observers in some localities near the margins of the historical range of brood X reported very low densities of periodical cicadas. These cicadas could be brood XIV cicadas that experienced four year accelerations of their life cycle. The distribution map of Pennsylvania's 2004 brood X cicadas provides a baseline dataset for a comparative study when they emerge in 2021.

KEY WORDS: Cicadidae, *Magicicada*, periodical cicada, geographic distribution, Pennsylvania, U.S.A.

Mapping the geographical distribution of periodical cicadas (Hemiptera: Cicadidae: *Magicicada* spp., photo on back cover) is a component of many investigations into the evolution of this fascinating group of insects (Lloyd and Dybas, 1966; Williams and Simon, 1995; Marshall and Cooley, 2000; Simon et al., 2000). Seventeen-year periodical cicada nymphs emerge in twelve distinct year-classes, or "broods" in the eastern United States. Each brood is a single-aged cohort of cicadas that emerge in the same year and is temporally isolated from other broods (Williams and Simon, 1995). When geographic ranges of broods overlap, the emergences are typically separated by four years (Williams and Simon, 1995). Three morphologically and behaviorally distinct *Magicicada* species (*M. septendecim*, *M. septendecula*, and *M. cassini*) can potentially coexist within a single brood. When *Magicicada* species coexist, they emerge simultaneously. Broods are designated with Roman numerals in a sequence that starts arbitrarily with the emergence of brood I in 1893 (Marlatt, 1898, as cited in Williams and Simon, 1995). Accordingly, brood X adults emerged in 1902 and have been succeeded by five generations. Nymphs hatching from eggs laid in 2004 will remain underground, feeding on xylem fluids until they emerge in 2021.

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A striking feature of periodical cicadas is the prodigious numbers often associated with their synchronous emergence; densities of over 3.5 million per hectare have been reported (Dybas and Davis, 1962). However, local periodical cicada densities are highly variable and distributions are scattered. Within each brood, most cicadas emerge from the soil and molt from their fifth larval instar to the adult stage within a few days of each other. Adult females mate, develop eggs and oviposit during the next 4-6 weeks. The importance of post-reproductive periodical cicadas to the forest ecosystem continues as large populations die and decompose. The resulting pulse of soil nutrients increases microbial biomass and plant productivity (Yang, 2004).

Maps of the approximate historical distribution of brood X periodical cicadas have been published by Lloyd et al. (1983) and Simon (1988). These maps have less than 40 coordinates plotted for Pennsylvania and are partially based on historical records that are difficult to verify. A subset of historical records of periodical cicada emergences in Pennsylvania and elsewhere has been compiled by Chris Simon and John Cooley (University of Connecticut). These records are posted in a searchable format in the "Periodical Cicada Database" (<http://collections2.eeb.uconn.edu/collections/cicadacentral/Databases/magidb.html>), and are cited with permission (Chris Simon, personal communication). This resource is primarily focused on modern records gathered by Simon and colleagues. It is not intended to serve as a comprehensive database of all periodical cicada records. However, this database serves as a convenient and accessible reference for county-level cicada records in Pennsylvania, which are not available in the published literature.

While most cicadas within a brood emerge in their "designated" year, a small number of cicadas may emerge sporadically in off-years, typically 1 year after, or 4 years before the majority of the brood (White and Lloyd, 1979; Williams and Simon, 1995; Marshall, 2001). Premature and late emergences can be due to mutations or gene combinations that affect life cycle (Martin and Simon, 1990a; Marshall and Cooley, 2000; Simon et al., 2000; Cooley et al., 2001 and 2003). Alternatively, local environmental conditions can also affect the emergence time of periodical cicadas (Martin and Simon, 1990a; Marshall, 2001). These cicadas are called "stragglers" whether they emerge prematurely or late (Marshall, 2001). Even a small number of male stragglers can be readily detected by their loud calling behavior (Marshall et al., 1996). Stragglers are generally not able to establish new self-replicating populations, because they emerge in such low numbers that they are quickly consumed by predators (Karban, 1982; Marshall, 2001). Historical records of stragglers that are attributed to the year-class in which they emerge have caused a considerable amount of confusion (Kritsky, 1988; Marshall, 2001). In the narrow context of assigning cicadas to a particular brood, low-density sightings should be interpreted carefully, as these cicadas may be stragglers from a different brood. In the larger context of evolution and biogeography, accelerated or delayed emergences on a massive scale are central to theories of new brood formation and speciation (Lloyd and Dybas, 1966; Lloyd and White, 1976; Simon et al., 2000; Marshall and Cooley, 2000).

The 2004 emergence of brood X cicadas provided us with an opportunity to use Geographic Information Systems (GIS) to map the 2004 geographic distribution of these insects within Pennsylvania. The 575 georeferenced positive cicada sightings or reports of the absence of cicadas were obtained in several different ways. Field-collected data coordinates allowed assessment of species composition and relative abundance. Contacting park managers and township officers by e-mail or telephone facilitated a survey of a much wider area, although these data only refer to the absence or presence of periodical cicadas. Several data coordinates were submitted to cicada-tracking websites, such as the Mid-Atlantic Cicada Database Project, at <http://www.cicadas.info/>, hosted by John Zyla, and <http://www.acnatsci.org/hosted/aes/cicada.html>, hosted by the American Entomological Society and were included in our dataset with permission (Jason Weintraub, personal communication). These data provide a baseline distribution for comparison with the emergence of brood X in 2021 and beyond.

METHODS

Twenty-two Pennsylvania state parks in which the emergence of periodical cicadas had been confirmed by park officers were visited in late May and early June 2004. Thirty Global Positioning System (GPS) coordinates were recorded with a *Garmin* GPS76 handheld unit in the parks. Visiting each site allowed us to document the presence or absence of each of the three species of periodical cicadas. The relative abundance was estimated by observing cicadas or their nymphal castes on trees in the area and also listening for the presence of cicada choruses. Georeferenced specimens were collected and stored in 100% ethanol. Distribution records were gathered by contacting 766 township officials by e-mail or telephone, from which 385 responses were obtained. An additional 46 state park officers were surveyed by telephone or e-mail. Only people within and closely surrounding the historical range of brood X (Lloyd et al., 1983) were contacted. Participants in our survey were specifically asked if they were familiar with the calls of *Magicicada* spp. and confident in their confirmation of the presence or absence of periodical cicada calls in their locality. Participants were not asked to differentiate among cicada species or to estimate relative abundance or density. An additional 109 coordinates were obtained from a website hosted by John Zyla (<http://www.cicadas.info/>). Five coordinates were taken from a website hosted by the American Entomological Society (<http://www.acnatsci.org/hosted/aes/cicada.html>). *ArcView* 3.3 (Environmental Systems Research Institute, Redlands, CA) was used to combine the data coordinates with a map of Pennsylvania county boundaries (Environmental Resources Research Institute, 1996) downloaded from the Pennsylvania Spatial Data Access (PASDA) website (<http://www.pasda.psu.edu>). The map coordinate system is the North American Datum (NAD) 1927 and the map projection is Albers Conical Equal Area (Fig. 1). The same georeferenced points were then mapped to the Pennsylvania physiographic provinces map (Pennsylvania Bureau of Topographic and Geological Survey, 1995) downloaded from the PASDA website. The map coordinate system is North American Datum (NAD) 1927 and the map projection is Lambert

Conformal Conic. A subset of 264 coordinates from surveys and park visits was mapped to a Pennsylvania elevation map (Fig. 3 Supplemental <http://www.muhlenberg.edu/depts/biology/faculty/edwards.html>).

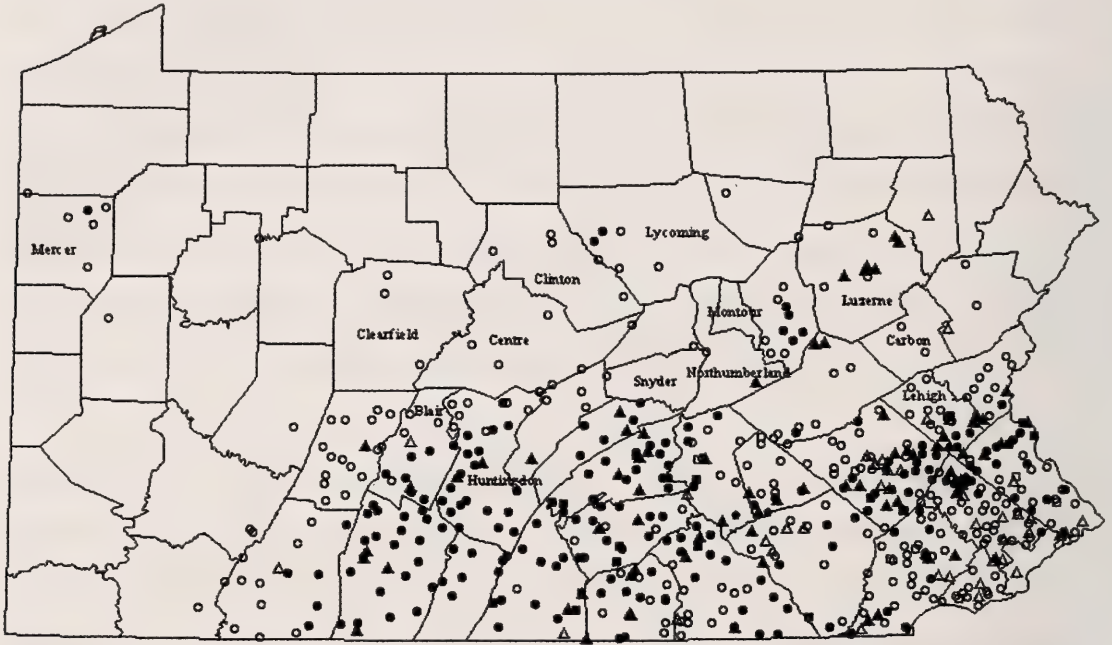


Figure 1. Distribution of brood X periodical cicadas in Pennsylvania as represented by individual coordinates. Closed symbols represent positive records of cicadas being observed. Open symbols represent records of no cicadas being observed. Squares represent our data coordinates that were collected in the field and for which data on species composition and habitat are available at <http://www.muhlenberg.edu/depts/biology/faculty/edwards.html>. Circles represent records from e-mail and telephone surveys of state park, township and other local officials. Triangles represent data coordinates that were submitted to a website hosted by John Zyla (<http://www.cicadas.info/>). Pentagons represent data coordinates that were posted on a website hosted by Jason Weintraub for the American Entomological Society (<http://www.acnatsci.org/hosted/aes/cicada.html>).

RESULTS

Data were plotted onto three different maps of Pennsylvania in order to assess factors that contributed to the 2004 brood X distribution pattern. All data coordinates are represented on a county map of Pennsylvania (Fig. 1). The coordinates of figure 1 are coded to represent the presence or absence of cicadas and also the source of the data. The data set of coordinates has been posted at <http://www.muhlenberg.edu/depts/biology/faculty/edwards.html>. A comparison between our data (Fig. 1) and historical records (Periodical Cicada Database) indicate that brood X periodical cicadas have been reported in several counties within the historical range of brood XIV cicadas (Table 1).

Table 1. Selected counties near the edge of the range of Pennsylvania brood X for which historical records have been collected (Periodical Cicada Database). These counties are named on the state map in Fig. 1.

COUNTY	2004 Records	Historical Brood X	Historical Brood XIV
Blair	8	4	21
Carbon	0	8	2
Centre	0	2	19
Clearfield	0	1	27
Clinton	0	2	30
Huntingdon	18	14	29
Lehigh	5	10	4
Luzerne	2	3	15
Lycoming	2	4	50
Montour	0	2	13
Northumberland	0	2	41
Snyder	0	5	28
TOTAL	35	57	279

In considering the range distribution of cicadas relative to physiography (Fig. 2) and elevation (Fig. 3 Supplemental), the northwestern edge of brood X's distribution appears to be influenced by the Allegheny Mountain Section. West of the Allegheny Mountain Section, historical records indicate the presence of brood VIII (Periodical Cicada Database). There are no records for brood VIII in the easternmost counties of the Allegheny Mountain Section. Both brood X (Fig. 2) and brood XIV (Periodical Cicada Database) are found within the Appalachian Mountain Section and portions of the Allegheny Front, but records diminish within the easternmost counties of the Allegheny Mountain Section and are absent in the western areas of this section.

In the northeastern distribution of brood X (Fig. 2 and Fig. 3 Supplemental) positive records decrease within the Great Valley Section, well in advance of the Appalachian Mountain Section to the north and in advance of any major increase in elevation. The northernmost reported points for brood X were in areas of low elevation within the Susquehanna River Valley (Fig. 1, Lycoming and Luzerne counties; Fig. 3 Supplemental).



Figure 2. Distribution of brood X periodical cicadas projected on a map of the physiographic provinces of Pennsylvania. Closed symbols represent positive records of cicadas being observed. Open symbols represent records of no cicadas being observed. Physiographic provinces highlighted in the text are numbered as follows: 1. Allegheny Mountain Section. 2. Allegheny Front Section. 3. Appalachian Mountain Section. 4. Blue Mountain Section. 5. Great Valley Section.

DISCUSSION

Maps of the national distribution of brood X have been redrawn from historical records and published by Lloyd et al. (1983) and Simon (1988). With the exception of a study on extermination methods by Asquith (1954), there have been no published investigations of periodical cicadas specifically in Pennsylvania. Pennsylvania was chosen as our study area to complement periodical cicada surveys that have been conducted in New Jersey (Schmitt, 1974), Ohio (Kritsky, 1988), and Iowa (Irwin and Coelho, 2000), and to serve as a baseline data set for future investigations of brood X cicadas in Pennsylvania. In the present study we mapped the distribution of periodical cicadas that emerged in Pennsylvania in 2004 to an unprecedented level of detail for the state (Figs. 1 and 2). These maps show the locally heterogeneous distribution of cicadas, which has not been depicted by national maps (Lloyd et al., 1983; Simon, 1988).

A question that predictably emerges with each periodical cicada brood, including brood X, is whether or not the range of the brood is changing. Declines in periodical cicada populations as a result of human disturbance have been of concern for more than a century (Butler, 1886, as cited in Dybas and Lloyd, 1974). Previous investigations of 17-year cicadas have indicated population contractions and local extinctions (reviewed by Williams and Simon, 1995). A 2001 population census indicated a contraction of the range of brood VII seventeen-year cicadas in upstate New York when compared to historical data (Cooley et al., 2004). Brood XI seventeen-year cicadas, which previously emerged in Connecticut and Massachusetts, have not been seen since 1954 (Manter, 1974, as cited in Cooley et al., 2004). Declines of brood X in New Jersey and Ohio, respectively, were documented by Schmitt (1974) and Kritsky (1988). Forest pest management entomologists with

the Pennsylvania Department of Conservation and Natural Resources conducted a statewide survey of 2004 periodical cicadas in Pennsylvania and reported adult cicadas in only 27 counties out of the 40 counties in which brood X cicadas have been historically documented (Spichiger, 2004). Due to differences in sampling methodologies and standards between our survey and previous distribution studies, it is not possible for us to assess whether there has been a major change in the 2004 distribution of Pennsylvania's brood X cicadas. However, our map provides a reference point for future studies on periodical cicada distribution.

The distribution of 2004 brood X cicadas relative to physiography and elevation (Fig. 2 and Fig. 3 Supplemental) appears to be influenced by the Allegheny Mountain Section. This physiographic region also appears to influence the distributions of broods VIII and XIV periodical cicadas (Periodical Cicada Database). None of these three broods have been found in the mid-section of the Allegheny Mountain Section. Brood X and XIV records diminish in the easternmost counties of the Allegheny Mountain Section. An eastern border of the brood VIII distribution appears to be in counties at the western edge of the Allegheny Mountain Section (Periodical Cicada Database).

The northernmost coordinates of Pennsylvania's 2004 brood X distribution (in Lycoming and Luzerne counties) were reported within or a few miles from the Susquehanna River Valley (Fig. 1 and Fig. 3 Supplemental). Previous studies have hypothesized that during historically cool periods, cicadas may be excluded from highlands and concentrated into low elevation areas with milder climate (Cooley et al., 2004). This phenomenon may have excluded cicadas from the Allegheny Mountain Section, and also kept them from migrating far from the Susquehanna River. In contrast, physiography does not appear to directly influence the north-eastern border of brood X, which diminishes within the Great Valley Section, south of the Blue Mountain Section. In the absence of an increase in elevation, an obvious change in vegetation such as coniferous forest (White et al., 1982), or competition from an adjacent brood (Periodical Cicada Database), this border of brood X remains difficult to explain.

At least some positive records of 2004 cicadas in Blair, Luzerne and Lycoming Counties may be stragglers of brood XIV, emerging 4 years earlier than the vast majority of the brood. These include Pennsylvania's northernmost cicada records, taken in Luzerne and Lycoming Counties, within or near the Susquehanna River Valley. In each of these counties, the majority of historical records are for brood XIV cicadas (Periodical Cicada Database; Table 1). Likewise, some counties in which brood X cicadas have historically been observed, but were not observed in 2004 (e.g. Centre, Clearfield, and Northumberland Counties), are within the historical range of brood XIV (Periodical Cicada Database). Although the Periodical Cicada Database is not intended to be a comprehensive record of all historical cicada sightings, searchable access to this limited data set is nevertheless a valuable starting point for analysis. Further analysis of the relationship of brood XIV stragglers to brood X will benefit from a thorough survey of the distribution and local population density patterns of Pennsylvania's brood XIV cicadas when they emerge in 2008. The proximity of Pennsylvania's distribution of brood X to brood XIV is probably not coincidental, as brood X has been hypothesized to have diverged from brood XIV through a massive four-year acceleration event (Lloyd

and Dybas, 1966). In this context, the 2004 absence of cicadas recorded in some Pennsylvania counties may not reflect a shift in the range of brood X, but rather fluctuations in the number of brood XIV cicadas with accelerated nymphal development.

A small number of periodical cicadas were heard at Maurice K. Goddard State Park in Mercer County (Donald Campbell, personal communication). Brood X cicadas have previously been reported in this far western county (Lloyd et al., 1983; Periodical Cicada Database). This small and isolated population deserves further study because periodical cicadas generally require high population densities to avoid predation and to reproduce (Lloyd and Dybas, 1966; Karban, 1982; Marshall, 2001). The Mercer County population may be an isolated remnant of a larger range of brood X that is headed towards a local extinction. Alternatively, these cicadas could be two-year stragglers of brood VIII, which emerged in 2002. Brood VIII is the only other brood with a historical distribution in this part of the state (Simon, 1988). Currently, there is no method that can be used to distinguish brood X from brood VIII cicadas of the same species. However, periodical cicada species in some other broods can be distinguished by among-brood differences in wing vein morphology, allozyme loci and mitochondrial DNA haplotypes (Simon, 1983; Martin and Simon, 1990b; Archie et al., 1985). The application of methods using new molecular markers could help elucidate the evolutionary history of "brood X" cicadas in Mercer County if they emerge in 2021.

Future survey methodologies should try to document the density of periodical cicada emergences. Very low density periodical cicada populations are not generally sustainable, due to predation pressures (Lloyd and Dybas, 1966; Karban, 1982; Marshall, 2001). Thus, georeferenced data on the density of cicada emergences in Pennsylvania may provide information about the possibility of a straggler origin of some of the records. Since brood X emerged in 1987, the worldwide web has allowed for a much greater degree of public participation in data collection on periodical cicadas. The accessibility and development of GPS and GIS technologies has facilitated mapping efforts, such as the fine-scale analysis of the 1997 brood III cicada emergence in Iowa (Irwin and Coehlo, 2000). It is our hope that our data for Pennsylvania's 2004 brood X cicadas will be useful for a comparative study when they emerge in 2021. Future surveys may reveal shifts in the distribution of Pennsylvania's brood X periodical cicadas that could be associated with long-term trends in land usage and climate change.

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THREE SHORT-WINGED SPECIES OF CHORTHIPPUS FIEBER FROM TURKEY (ORTHOPTERA: ACRIDIDAE: GOMPHOCERINAE)¹

Mustafa Ünal²

ABSTRACT: *Chorthippus demokidovi* (Ramme), *C. satunini* Uvarov and *C. taurensis* Sirin and Ciplak are studied from Turkey. A key to the three species is prepared. Illustrations and comparisons with their allies are given.

KEY WORDS: systematics, Orthoptera, Gomphocerinae, *Chorthippus*, Turkey, key

Chorthippus Fieber, 1852 is one of the largest genera in the subfamily Gomphocerinae with more than 200 species and subspecies (Otte, Eades and Nas-krecki, 2002). Twenty-two species and subspecies were so far reported from Turkey (Demirsoy, 1977; Ünal, 2003). In this paper the three species of Turkish gomphocerines with characteristic shape of shortened tegmina in both sexes are compared. Although the particulars of the forewings are shared with many other Eurasian *Chorthippus*, their putative closest relatives are found in Lebanon, Israel, Greece, Georgia, Armenia, Nakhichevan, and Iran.

Chorthippus demokidovi (Ramme, 1930) was described from western Armenia as *Stenobothrus demokidovi* Ramme, 1930. Karabağ (1958) recorded it for the first time from Turkey (Bingöl Dağları, Zarovan and Şevti Yaylası). Later, Demirsoy (1975) recorded it again from Turkey, between Çat and Bingöl Dağları (Erzurum). But Demirsoy's short description, measurements and illustration might refer to another species. Finally, Salman (1978) collected rich material (35 males and 36 females) from Artvin, Kars and Iğdir provinces in northeastern Turkey.

Chorthippus satunini Mistshenko, 1951 was described from Turkey (Oltu) (Bey-Bienko and Mistshenko, 1951). Karabağ (1956, 1958) recorded it from Hakkari Province, southeastern Turkey. Weidner (1969) discussed the similarity of this species with *C. demokidovi* and considered them as separate taxa. However, Demirsoy (1977) listed all previous records of *C. satunini* under *C. demokidovi*.

Chorthippus pygmaeus (Bey-Bienko, 1931), known from Nakhichevan (Azerbaijan) was recorded from eastern Turkey (Bitlis) by Önder et al. (1999), though based on a single specimen. But this specimen probably belongs either to *C. satunini* or *C. demokidovi*. *C. pygmaeus* was synonymized by Ramme (1951) but with a question mark.

Abundant material preserved in the Natural History Museum (NHM, London, England, U.K.), collected in Turkey by K. M. Guichard and D. H. Harvey during their expeditions in 1959, 1960, and 1962, represents a fine series which agrees with the descriptions of *C. demokidovi* and *C. satunini*. Among this material

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another, apparently hitherto unknown but allied species of *Chorthippus* was found. While my description of the species was already preliminarily composed and about to go to the printer, I learned that the same species presumably would be published earlier, as *Chorthippus taurensis* Sirin and Ciplak, 2005 (in Ciplak et al. 2005). However, herein I offer my description, including key characters, geographical distribution, and comparisons with species considered allied as I think they will be useful for readers to see these from a different point of view. Apart from the above mentioned publications, there are no further records of these three taxa from Turkey. These, as well as other related gomphocerines such as *C. abchasicus* Ramme, 1939 from Georgia, *C. savalanicus* Uvarov, 1933 from N.W. Iran and *C. mistshenkoi* Avakian, 1956 from Armenia should be compared to each other as perhaps, some of them are conspecific. Other morphologically similar and geographically close species, such as *C. willemsei* Harz, 1971 and *C. pulloides* Ramme, 1926 from mainland and the Peloponnisos of Greece, *C. biroi* (Kuthy, 1907) from Crete, *C. lebanicus* Massa and Fontana, 1998 from Lebanon, *C. dirshi* Fishelson, 1969 from Israel and *C. hyrcanus* Bey-Bienko, 1960 from N. Iran, which appear to constitute a species group.

The material used in this study was loaned by the NHM. Identification and illustration were done in the Abant İzzet Baysal Üniversitesi Entomoloji Müsesi (AIBUEM), Bolu. Six specimens of the three species listed here are deposited in the AIBUEM. All others are deposited in the NHM.

***Chorthippus (Glyptobothrus) taurensis* Sirin and Ciplak, 2005**

Figs. 1-8, 13.

Ciplak et al., 2005, Trans. Am. Ent. Soc., 131(3+4): 473.

Redescription. Male: Body, fore and middle legs with sparse hairs. **Head** (Fig. 1): Antennae distinctly longer than head and pronotum together. Head (Fig. 1) almost as broad as pronotum. Face oblique, frontal ridge with flat surface; fastigium oblique without hair; foveolae 2.2 times longer than wide; concave with rounded margins. Eyes 1.7 times longer than subocular groove. **Pronotum** (Fig. 1) slightly longer than head; anterior margin slightly convex, posterior margin obtuse angular; median and lateral carinae distinct; median carina cut by transverse sulcus just behind the middle (5.4/10 from anterior margin); lateral carinae distinct, strongly bent in prozona under an angle; lateral lobes of pronotum slightly lower than long; metazona a little convex in lateral view. Mesosternal space a little broader than long but narrower than mesosternal lobes. Metasternal space quadrangular. Tegmina (Fig. 2) 3.8 times longer than wide; its apex broadly rounded, with distinct precostal field; always shorter than abdomen, reaching end of 7th abdominal tergite, in other males reaching to half of 5th tergite; costal field twice as broad as subcostal field; median field as broad as costal field and twice as broad as cubital field. Wings almost half length of tegmina, in other males 1.5-1.7 times shorter than tegmina; reaching to beyond 3rd abdominal tergite. Hind

femur 3.8 times longer than wide. Stridulatory file 3 mm long, with 84 pegs; in 1 mm with 35 stridulatory pegs in middle part. Arolium broad, half as long as claws, in other males slightly longer than claws. **Abdomen:** Tympanal opening oblique rectangular, its largest diameter 3 times longer than the smallest diameter. Subgenital plate (Fig. 3) short and almost rounded, slightly pointed at apex. Cercus compressed laterally, pointed at apex; twice as long as broad. Penis valves (Fig. 4) slender, anterior valves longer than posterior valves. Epiphallus as in Fig. 5.

Female: Body with sparse hairs. **Head** (Fig. 6): Antennae almost as long as head and pronotum together. Faveolae 3 times longer than wide, in other females 2.5-3 times longer than wide. Frontal ridge slightly punctate. Eyes 1.3 times longer than subocular groove. **Pronotum** (Fig. 6) longer than head; anterior margin convex, posterior margin with obtuse angle; median keel cut by transverse sulcus just behind the middle (0.55/1 of total length); lateral keels strongly bent in prozona under an angle; prozona and metazona slightly convex in lateral view; lateral lobes lower than length of pronotum. Meso- and metasterna as in male. Tegmina (Fig. 7) 3 times longer than wide, its maximal width at proximal part; its apex rounded; reaching to end of 4th abdominal tergite; radius and costa straight; precostal field distinctly projected; costal field wide, 5 times broader than subcostal field; median field twice as broad as cubital field. Wings almost 1.5 times shorter than tegmina, reaching to half of 3rd abdominal tergite. Hind femur 4 times longer than wide. Arolium half length of claws. **Abdomen:** Tympanal opening elliptical, its largest diameter 2.6 times longer than the smallest diameter. Subgenital plate triangular at apex. Ovipositor (Fig. 8) with short and sharp valves.

Color. Body various shades of brown with black spots, stripes and bands. Hind femur with an oblique black band at inner face. Hind knee not darkened, concolorous. Hind tibia reddish brown in male, yellowish brown in female.

Material examined. Konya Province, Beyşehir, Yeniköy (Fig. 13), 5500ft, 3 October 1960, 4 males, 9 females (leg. K.M. Guichard and D.H. Harvey).

Distribution (Fig. 13). TURKEY: W. Mediterranean Region of Turkey.

Remarks. This species is characterized by the shape and venation of the short tegmina which in both sexes never reach to the end of abdomen, the broadly rounded and unpointed apex of the male tegmina, the rounded apex of the female tegmina, the shortened hind wings (almost half of tegmina), the pronotum with strongly bent lateral keels, the narrow tympanal opening and the size. This species is related other short-winged species as: *C. willemsei* Harz, 1971, *C. biroi* (Kuty, 1907), *C. pulloides* Ramme, 1926, *C. satunini* Mistshenko, 1951, *C. demokidovi* (Ramme, 1930), *C. abchasicus* Ramme, 1939, *C. savalanicus* Uvarov, 1933, *C. pygmaeus* Bey-Bienko, 1931, *C. mistshenkoi* Avakian, 1956, *C. hemipterus* Uvarov, 1926, *C. hyrcanus* Bey-Bienko, 1960, *C. dirshi* Fishelson, 1969 and *C. lebanicus* Massa et Fontana, 1998 which are distributed in the adjacent territories of Turkey and two of them in Turkey. The distinction concerns the shape of tegmina in both sexes, tympanal openings and pronotum. It is more similar to *C. pulloides*, *C. satunini*, *C. demokidovi*, *C. lebanicus* by the general structure of tegmina (unpointed at apex in male) and the narrow tympanal openings (its largest

diameter 2.5-3 times longer than the smallest diameter). However, shape and venation of tegmina in both sexes (most obvious in the female), the reddish hind tibia in the male, the pronotum, genitalia and larger size are different. The distinction with the closely allied Turkish species *C. satunini* Uvarov and *C. demokidovi* Ramme is given below in the key.

***Chorthippus (Glyptobothrus) demokidovi* (Ramme, 1930)**

Figs. 9-10, 13.

Ramme, 1930, 1951; Bey-Bienko and Mistshenko, 1951; Karabağ, 1958; Weidner, 1969; Demirsoy, 1975, 1977; Salman, 1978, Stolyarov, 1997.

Material examined. TURKEY: Ağrı Province (in the label: Kars Province), Küçük Ağrı Dağı, Serdarbulak, 8-10000 ft, 2 September 1960, 13 males, 6 females (leg. K.M. Guichard and D.H. Harvey).

Distribution (Fig. 13). W. ARMENIA: Alagös. N.E. TURKEY: Erzurum Province, Bingöl Dağları; Bingöl-Erzurum; Ağrı Province, Gezez Dağları; Iğdır province, Büyük Ağrı Dağı; Kars Province, Kağızman; Artvin Province, Borçka (Ramme, 1930; Karabağ, 1958; Demirsoy, 1975; Salman, 1978; Stolyarov, 1997).

Remarks. This is the smallest species examined here and easily recognizable by the female tegmina. The records of Artvin, Erzurum and Bingöl provinces should be confirmed.

***Chorthippus (Glyptobothrus) satunini* Mistshenko, 1951**

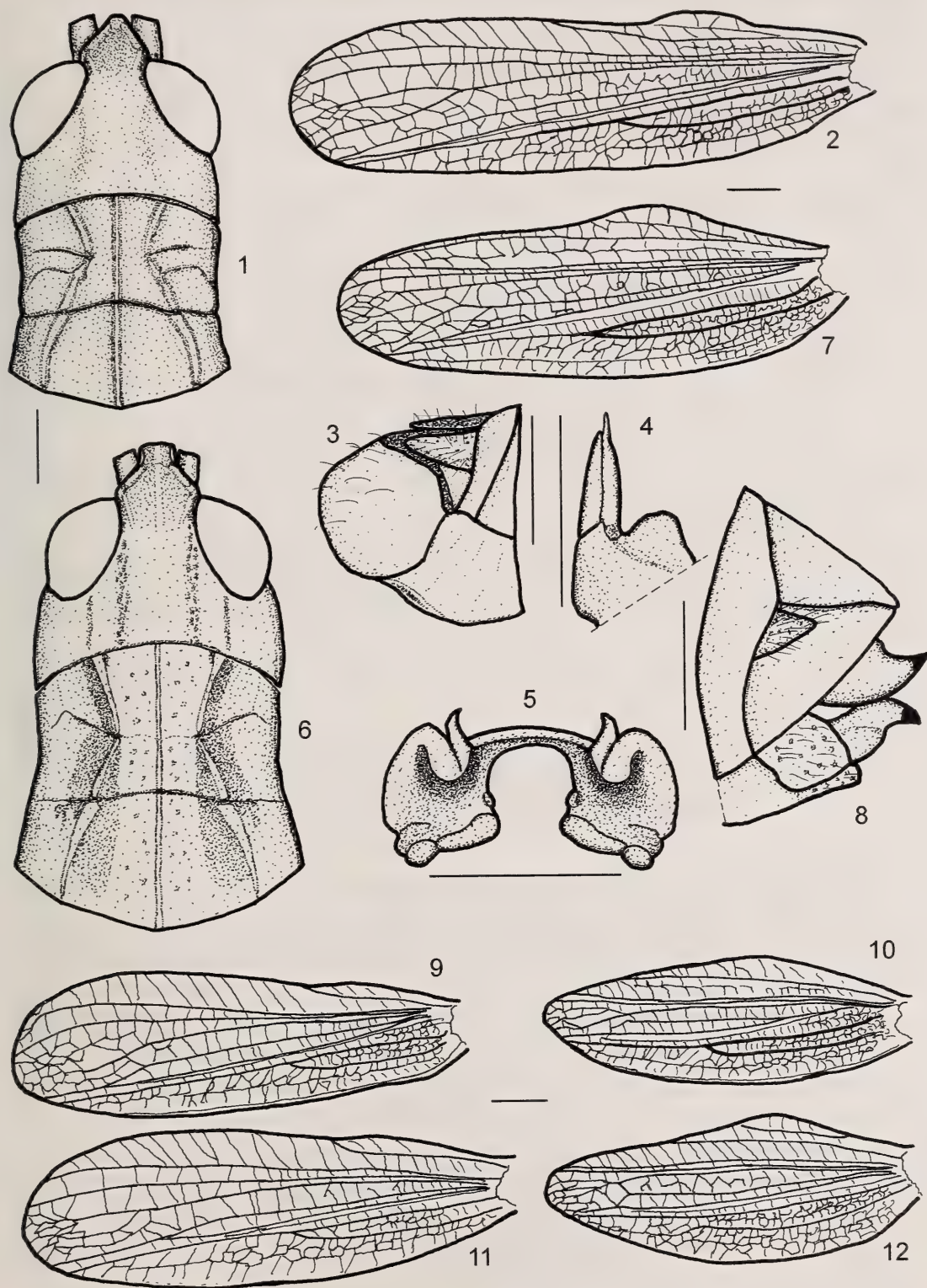
Figs. 11-13.

Bey-Bienko and Mistshenko, 1951; Karabağ, 1956, 1958; Weidner, 1969.

Material examined. TURKEY: Erzurum Province, Kopdağı Geçidi, 6-7000 ft, 23 July 1960, 6 males, 7 females; Bayburt Province (in the label: Gümüşhane Province), Soğanlı Geçidi, 6000 ft, 25 July 1960, 4 males, 2 females (leg. K.M. Guichard and D.H. Harvey).

Distribution (Fig. 13). E. TURKEY: Erzurum Province, Oltu; Hakkari Province, Karadağ (Bey-Bienko and Mistshenko, 1951; Karabağ, 1956).

Remarks. This species is very similar to *C. demokidovi*, but the female tegmina, details of the male tegmina and the size are different. Both taxa might have been confused by previous authors and this material should be re-examined.



Figures 1-12. Figs. 1-8. *Chorthippus taurensis* 1, male head and pronotum; 2, male left tegmen; 3, male end of abdomen; 4, penis valves; 5, epiphallus; 6, female head and pronotum; 7, female left tegmen; 8, female end of abdomen. Figures 9-10. *Chorthippus demokidovi* 9, male left tegmen; 10, female left tegmen. Figs. 11-12. *Chorthippus satunini* 11, male left tegmen; 12, female left tegmen. Scales = 1 mm.

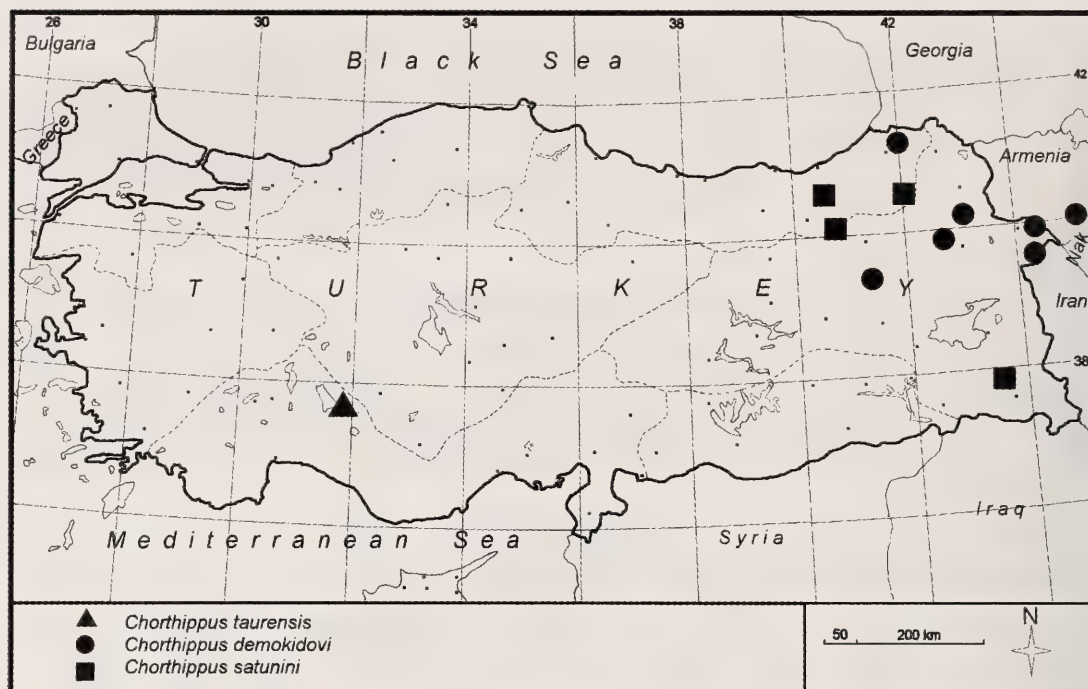


Figure 13. Distribution of the three Turkish species of *Chorthippus* discussed in this paper.

Key to the Turkish species of *Chorthippus* shortened tegmina in both sexes

1. Male tegmen with precostal field distinctly projecting (Fig. 2). Hind tibia reddish-brown in male. Female tegmen 7-7.5 mm, rounded at apex (Fig. 7). Body size large 15.9 mm in male, 18.7 mm in female (Table 1).....*C. taurensis*

Male tegmen with precostal field slightly projecting (Figs. 9 and 11). Hind tibia yellowish-brown in male. Female tegmen shorter than 5.4 mm, pointed at apex (Figs. 10 and 12). Body size smaller than 13.8 mm in male, 16.5 mm in female (Table 1)

2. Female tegmen 2.8 times longer than wide; with slightly projecting precostal field (Fig. 10). Male tegmen with venation as in Fig. 9. Body size: 9.3-11.5 mm in male, 13.5-15.5 mm in female (Table 1)*C. demokidovi*

Female tegmen 2.4 times longer than wide; with distinctly projecting precostal field (Fig. 12). Male tegmen with venation as in Fig. 11. Body size: 11.4-13.8 mm in male, 15.2-15.5 mm in female*C. satunini*

Table 1. Range of measurements (mm) of *Chorthippus* material examined and previous data (pd.). These numbers are not averages. If there is a single number, all measurements are the same. “Previous data,” pd., represents reports of measurements of these species in other papers (Bey-Bienko and Mistshenko, 1951; Ramme, 1951).

Species	Body	Tegmina	Pronotum	Hind Femur
males				
<i>C. demokidovi</i>	10.2-11.4	5.9-6.2	2.4-2.5	7.4-7.5
pd.	9.3-11.5	5.1-6.8	2.5	7.2-8
<i>C. satunini</i>	12.2-13.8	6.5-7.2	2.6-2.8	7.6-8.4
pd.	11.4	7.1	-	-
<i>C. taurensis</i>	15.9-16.8	7.4-8.2	3.1	9.1-9.5
females				
<i>C. demokidovi</i>	14.7-15.5	4.2-5.6	2.9-3	8.4-8.9
pd.	13.5-15.5	3.7-5.1	2.9-3.1	8.2-9.2
<i>C. satunini</i>	15.2-16.5	4.5-5.4	3-3.6	9-9.7
pd.	-	-	-	-
<i>C. taurensis</i>	18.7-20.2	7-7.5	3.8-4	11.4-12

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TWO NEW GENERA AND SPECIES OF STENOCRANINE PLANTHOPPERS (HEMIPTERA: DELPHACIDAE) FROM NORTH AMERICA¹

Charles R. Bartlett²

ABSTRACT: Two new species and genera of stenocranine delphacid planthoppers are described and illustrated. *Kelisicranus* n. gen. has a subanal process heretofore known only from members of the subfamily Kelisiinae. *Kelisicranus arundiniphagus* n. sp. is described from specimens taken in the Great Smoky Mountains National Park. *Obtusicranus* n. gen. is unusual in having a doubled median carina of the frons. *Obtusicranus bicarinus* n. sp. is the first stenocranine planthopper described from Arizona and Colorado.

KEY WORDS: Homoptera, Auchenorrhyncha, Fulgoromorpha, Fulgoroidea, Stenocraninae, Stenocranini, Great Smoky Mountains National Park, ATBI

Two new genera and species of stenocranine planthoppers are here described. One of these was discovered in the collection of the Great Smoky Mountains National Park, and is described as a component of the ongoing All Taxon Biotic Inventory (ATBI) (Sharkey 2001, Bartlett & Bowman 2004). The second new genus was discovered among undetermined specimens from the Snow Entomological Museum, Lawrence, KS, from Arizona and Colorado.

The stenocranine planthoppers are advanced delphacids, treated as either a full subfamily (Stenocraninae) (Asche 1985, 1990), or a tribe (Stenocranini) within the Delphacinae (Emeljanov 1996). Preliminary combined molecular and morphological phylogenetic maximum parsimony analyses places the Stenocraninae as a sister group to the Kelisiinae (Cryan and Bartlett, unpublished data).

Worldwide, the Stenocraninae consist of 5 genera and 75 species, as follows: *Embolophora* Stål 1855 (3 species, African), *Preterkelisia* Yang 1989 (1 species, *P. magnispinosus* [Kuoh, 1981 in Ding & Kuoh, 1981], Oriental), *Stenokelisia* Ribaut, 1934 (1 species, *S. angusta* Ribaut, 1934, France & Yugoslavia, Nast, 1987), *Terauchiana* Matsumura, 1915 (5 species, Oriental & eastern Palearctic), and *Stenocranus* Fieber, 1866 (65 species, widespread, mostly Laurasian). *Stenocranus* is the largest genus, and the only genus described from the New World, however, it is apparently not monophyletic (Asche & Remane 1982, Asche 1985). New World *Stenocranus* consist of 15 species (Metcalf 1943, Beamer 1946a, b), one of which *S. luteivitta* Walker, 1851, was placed in *incertae sedis* by Beamer (1946a). *Stenocranus maculipes* (Berg, 1879) from Argentina is the only New World *Stenocranus* not from North America.

The features of the Stenocraninae are (Asche 1990): Aedeagus with a sclerotized central sperm-conducting shaft, at least partially surrounded by a mostly membranous theca. Theca with at least one curved, horn-shaped process.

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Females ditrysic. Second abdominal sternite of male drumming organ with small shell-like or armlike apodemes directed caudad. Calcar large, flattened, with numerous small teeth on inner margin. Kelisiinae (consisting of about 50 species in 2 genera) differ mostly in having a more solid, less concave calcar, and by the presence of a single or paired elongate, rodlike process from link between bases of aedeagus and anal segment (subanal processes), although they also differ in more subjective features such as the form of the aedeagus and chroitic features.

Terms for morphological features follow Asche (1985), except the "basal angle" of the parameres from Metcalf (1949), the carinae of the head (Fig. 1) follow Yang and Yang (1986), and "gonoplacs" (for 3rd valvulae) is used following Chapman (1998). Body length measurement is from apex of vertex to tip of wing from several specimens as specified; other measurements, ratios and angles were observed from the type specimen. The "angle of the fastigium" is determined as the convergence of the general planes of the vertex and frons in lateral view. All measurements are in millimeters (mm). The most recent revision of North American *Stenocranus* was Beamer (1946a). This work relied on features of wing venation to key species, although no interpretation of venation was provided. Wing venation here follows the conceptual scheme of Kukalová-Peck (1983) as interpreted for Auchenorrhycha by Dworakowska (1988). Acronyms for specimen depositories are (following Arnett et al., 1993): GSNP, Great Smoky Mountain National Park collections, Sugarlands Visitor's Center, Gatlinburg, TN; SEMC, Snow Entomological Collection, University of Kansas, Lawrence, KS; USNM, United States National Museum of Natural History, Smithsonian Institution, Washington, DC; UDCC, University of Delaware Insect Reference Collection, Department of Entomology and Wildlife Ecology, Newark, DE.

The following two new species have features that differ substantially from the described New World *Stenocranus*, and are therefore placed in new genera. The North American *Stenocranus* is at present being revised, including a reconsideration of its generic limits (S. W. Wilson, pers. com.). The upcoming generic revision should clarify the relationships among these new genera and other New World stenocranines.

***Kelisicranus* NEW GENUS**

Type species. *Kelisicranus arundiniphagus* n. sp.

Diagnosis. Head produced well beyond eye, fastigium angle acute. Median carinae of frons single. Calcar thickly foliate, tectiform, with many small, black-tipped teeth on lateral margin. Gonoplacs not expanded. Male genitalia with forcepslike parameres. Diaphragm of pygofer strong, armature absent. Aedeagus long, fine; resting within phallosome caudad of articulation with segment X. Connective between segment X and phallosome bearing subanal process. Segment X with two strong, widely separated processes from dorsolateral margins.

Remarks. The presence of a subanal process, a feature normally associated with the Kelisiinae, separate this genus from all other Stenocraninae. The normal (unexpanded) gonoplasts also separates this species from all New World *Stenocranus* except *S. similis*. None of the North American *Stenocranus* have their head as projected or as acute in lateral view as *Kelisicranus*.

The subanal process in this genus is an unusual feature previously considered an autapomorphy of the Kelisiinae. The nature of the calcar, the theca, size, coloration, and host (Kelisiinae are sedge feeders), however, all suggest Stenocraninae. Also, none of the Kelisiinae that I am aware of (e.g., Ribaut 1934, Beamer 1945, 1951, Asche 1985, Holzinger et al., 2003) have processes on segment X. The presence of a subanal process suggests that Stenocraninae and Kelisiinae are more closely related than previously suspected (by, e.g., Asche & Remane 1982, Asche 1985, Emeljanov 1996).

Etymology. The generic name is a compound term formed by combining the generic name *Kelisia* with the terminus of *Stenocranus*. It is an arbitrary combination of letters to be treated as masculine.

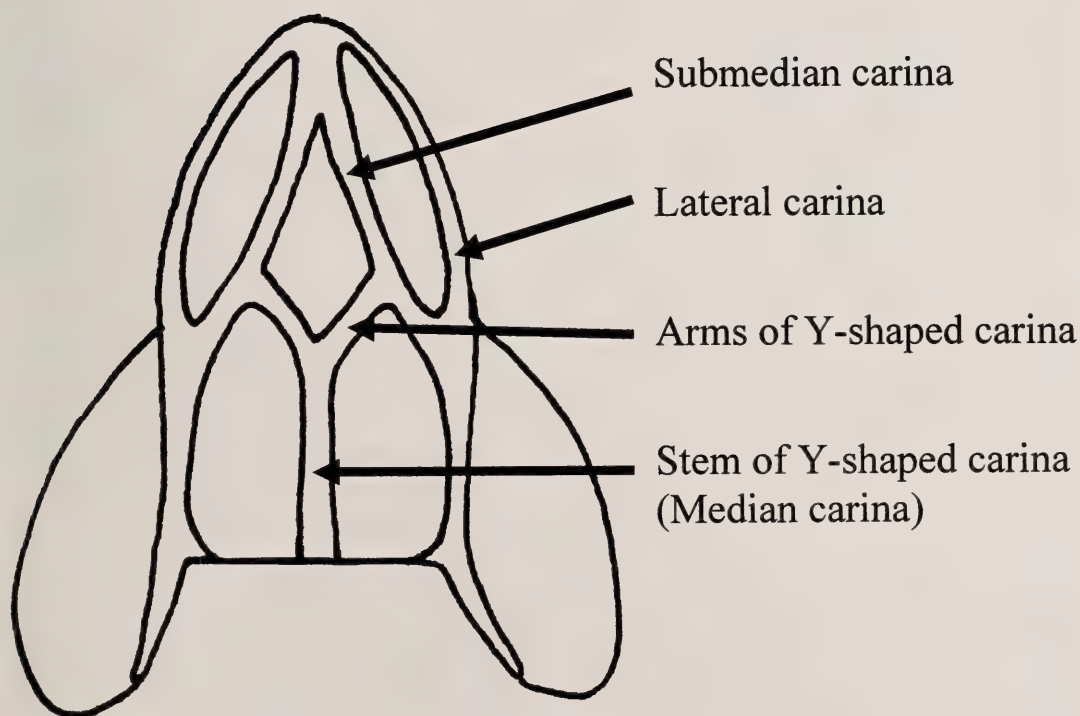


Figure 1. Head of *Obtusicranus bicarinus* n. sp. showing nomenclature of head carinae.

***Kelisicranus arundiniphagus* NEW SPECIES**

(Figs. 2, 4a, b; 5, 6a)

Type Locality. USA, TN, Great Smoky Mountains National Park, Cades Cove.

Diagnosis: Color. Body tan; face (frons + clypeus + labrum), carinae of vertex and nota paler; darker on anterior lateral compartments of vertex, lateral margins of head both anterior to compound eyes and to either side of subocular suture. Thorax tan ventrally, with irregular dark spots on dorsal region of pleuron. Legs yellowish with darker foveae. Macropterous wings slightly infumed, with marginal dark spots just proximad to fused anal veins on clavus (wing coupling area), and at tip of each vein reaching wing margin except CuP (claval suture); also each longitudinal vein darkened for short length just posterior to crossveins in apical fourth of wing. Dorsum of abdomen dark brown with paler middorsum and posterior tergal margins, with highly irregular paired pale spots subdorsally and midlaterally on each tergum suggesting vittae. Venter of male abdomen with midventral and posterior sternite margins pale yellow, contrasting with dark sublateral patches, becoming paler laterally; segments IV-VI with irregular midlateral pale spots on both sides of median line. Male pygofer tan, paler ventrally and caudally. Female abdominal venter with segments III-VI similar to male except with a pair of small, dark midlateral spots on both sides of midline; gonoplares pale yellow, gonapophyses slightly darker.

Structure: Body length: ♂ 5.5 mm (5.1-5.7, n=4), ♀ 6.0 (5.75-6.50, n=5). Head, including eyes, narrower than pronotum (0.83:1); distinctly projecting in front of eyes (Fig. 2a). Posterior margin of vertex excavated between compound eyes, posterior margins slightly sinuate, acutely concave medially. Vertex much longer (0.60 mm) than wide (0.25 mm) projected beyond eye for approximately 0.6x eye width. Lateral margins of vertex in dorsal view subparallel, converging anteriorly; in lateral view meeting lateral carinae of frons with bluntly acute angle at fastigium (Fig. 2c). Angle of fastigium approximately 40°. In dorsal view, median carinae of vertex conspicuous, arms reaching submedian carinae in anterior quarter of eyes (Fig. 1). Submedian carinae of vertex slightly raised above level of lateral carinae, forming acuminate apex, meeting approximately at or just beyond fastigium. Frons narrow (0.25 mm) and long (1.03 mm), slightly widened at eyes (Fig. 2b); lateral carinae subparallel. Postclypeus and anteclypeus with conspicuous median carinae, together 0.6x length of frons. Rostrum reaching mesocoxae. Subocular suture conspicuous ventrally, curved in dorsal quarter toward anterior margin of eye, becoming obsolete dorsally. Antennae terete, segment I subequal in length and width, II 3x length of I. Pronotum in dorsal view approximately half as long as vertex, narrowing anteriorly, both on posterolateral margins behind eyes and within head excavation between eyes; anterior apex truncate; posterior margin broadly, obtusely concave. Three conspicuous pronotal carinae, reaching hind margin. Three carinae of mesonotum conspicuous; not reaching posterior margin; lateral carinae diverging posteriorly.

Wings rounded apically, row of crossveins in apical third (Fig. 6a). Hindwings as long as forewings. Metatibia with two lateral spines. Metabasisarsus as long as tarsomeres 2 + 3 combined; spinulation of metabasisarsus 7 (2 + 5), 2nd 4. Calcar approximately 0.5x total length of basisarsus; thickly foliate, tectiform, with many (ca. 20) small, black-tipped teeth on lateral margin.

Male genitalia with pygofer subtriangular in lateral view (Fig. 4a), ventral and dorsal sides subequal, projecting slightly on either side of parameres. Pygofer posteriorly smoothly rounded into diaphragm; diaphragm sclerotized, without armature. Parameres directed caudodorsally, forcepslike, abruptly tapered in apical fifth to dorsally directed apices; basal angle obscure (Fig. 4b). Aedeagus long and fine, sclerotized; enclosed within apically bifid, weakly sclerotized phalotheca beyond base of anal segment; thecal apex with ventral process half as long as falciform dorsal projection. Segment X elongate; approximately 0.8x as tall as pygofer; bearing two long, stout, symmetrical processes from dorsolateral corners; slightly sinuate from lateral view. Segment X with a single, fine projection, 0.2 mm long, arising medially from base of ventral margin, adhering close to ventral aspect of anal segment (subanal process, Fig. 5). Anal tube elongate and conspicuous. Female with gonoplares not expanded (Fig. 2d).

Remarks. Of the North American species of stenocranines, only *Stenocranus similis* Crawford, 1914, shares with *K. arundiniphagus* the normal (i.e., not expanded) gonoplares, but *Kelisicranus* differs from *S. similis* and other North American *Stenocranus* in having its head strongly projecting forward. *Kelisicranus arundiniphagus* differs considerably from *S. similis* and other North American *Stenocranus* in chroitic features, particularly in having its frons uniformly pale in contrast with darker geneae. *Kelisicranus* differs from *Obtusocranus* by the gonoplares and subanal process and the shape of the head. In *Kelisicranus* the frons is longer and narrower than *Obtusocranus*, and the angle of the fastigium is more acute in *Kelisicranus*.

This species is described as a part of the All Taxon Biotic Inventory of the Great Smoky Mountains National Park (Sharkey 2001, Bartlett & Bowman 2004). The host information reported on the label (“bamboo”) appears to refer to giant or river cane (*Arundinaria gigantea*), which is present in Cades Cove, with some plants reaching 4 m height. I examined giant cane in July 2003 for *Kelisicranus arundiniphagus* (or possibly *Stenocranus arundinarius*), but found only *S. similis*.

Material Examined. Holotype: “GRSM Blount CO/ TN Cades Cove/ Bamboo 6 IV 1995/ D. Novikov //HOLOTYPE/Kelisicranus/arundiniphagus/ Bartlett” (♂, USNM). Paratypes: 7 specimens on 5 pins, same data as holotype (6♀, 1♂, GSNP); 22 specimens on 9 pins, same data as holotype except 11 IV 1995 (19♀, 1♂ GSNP, 1♀, 1♂ UDCC).

Etymology. The specific name is an arbitrary combination of letters, to be treated as masculine, formed by combining “*Arundin-*” from *Arundinaria*, with “*phag*” (eat, from Greek) Latinized with the male ending “*-us*,” connected with an “*i*” (see ICZN 1985, table VII p. 203).

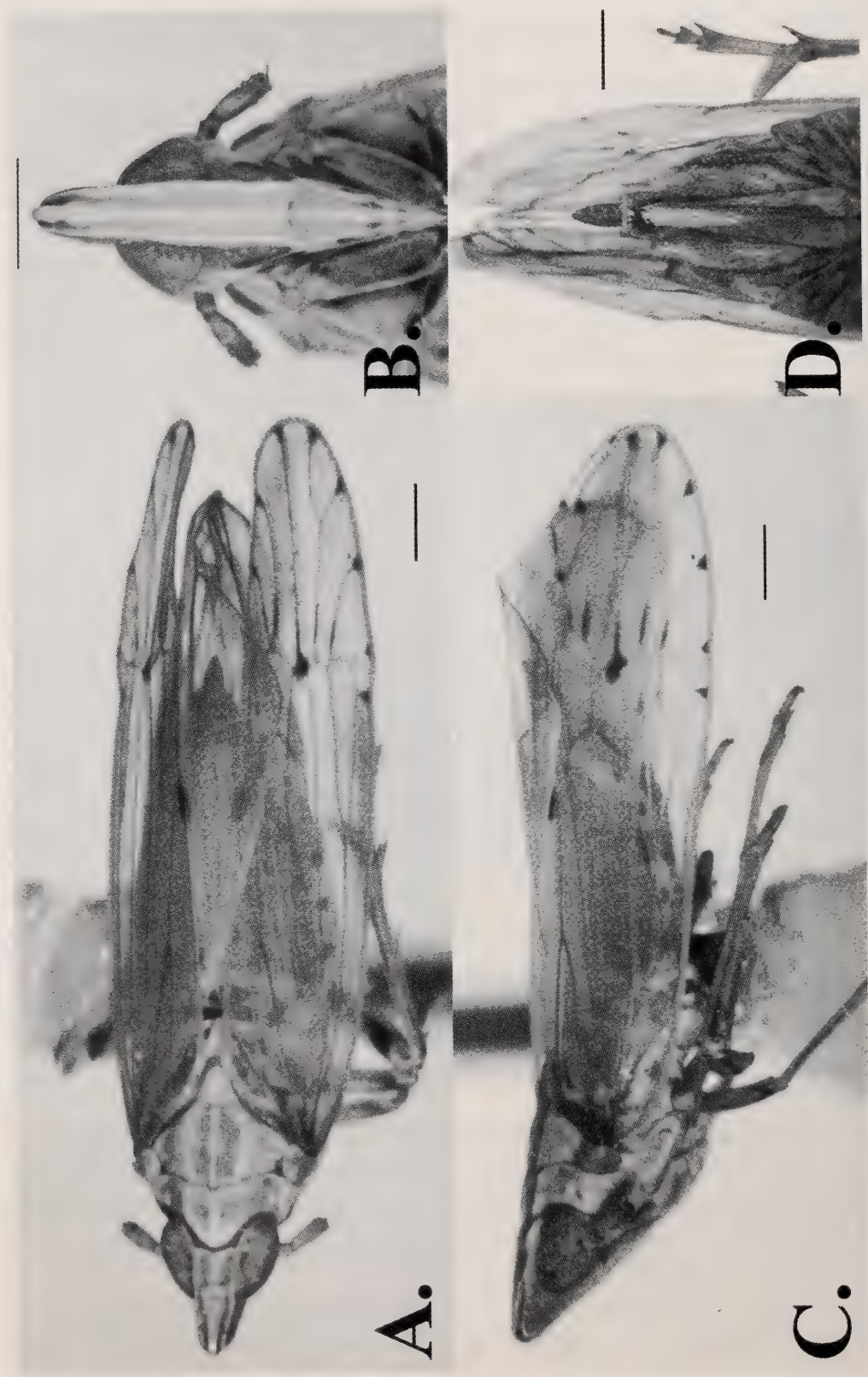


Figure 2. *Kelisicranus arundiniphagus* n. sp. A. dorsal view, B. frons, C. lateral view, D. ventral view of ovipositor. Scale bar = 0.5 mm.

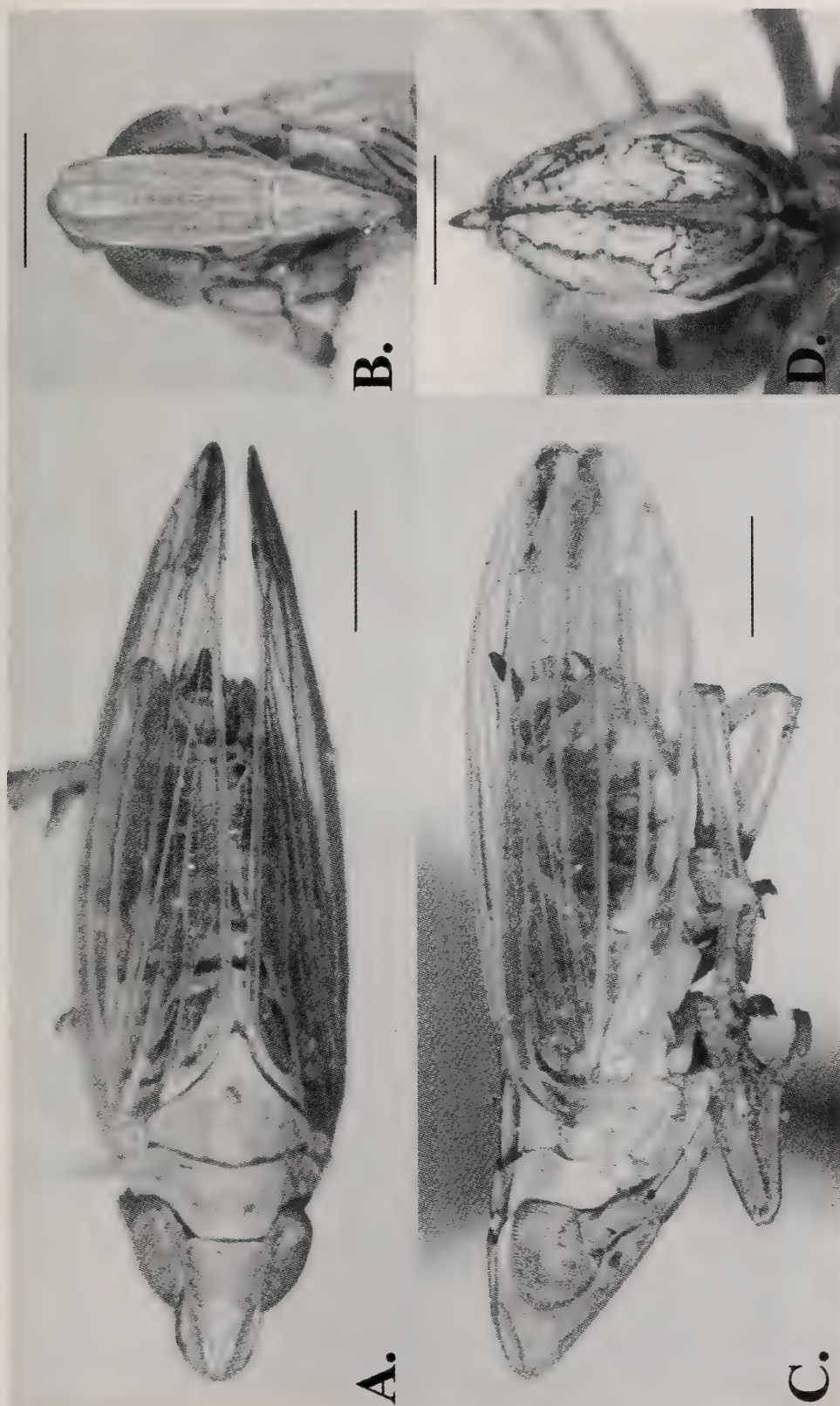


Figure 3. *Obtusicranus bicarinus* n. sp. A. dorsal view, B. frons, C. lateral view, D. ventral view of ovipositor. Scale bar = 0.5 mm.

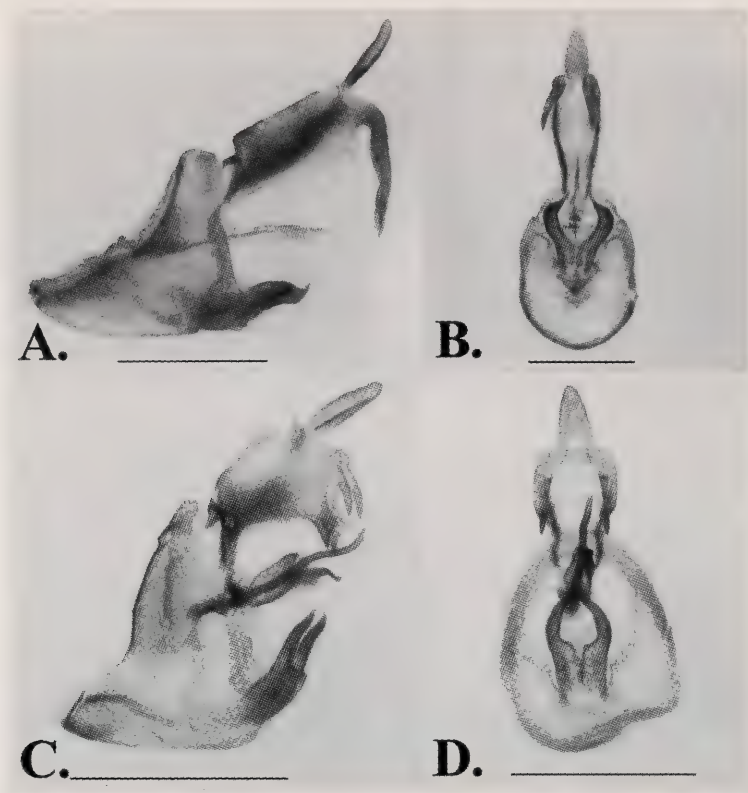


Figure 4. Male terminalia. A. *Kelisicranus arundiniphagus*, lateral view, and B. caudal view; C. *Obtusicranus bicarinus*, lateral view and D. caudal view. Scale bar = 0.5 mm.

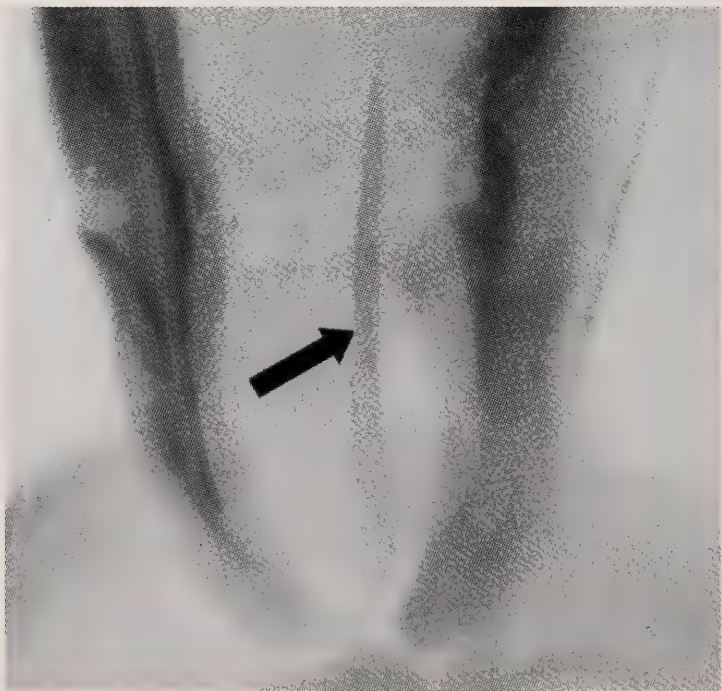


Figure 5. Subanal process of *Kelisicranus arundiniphagus* (arrow).

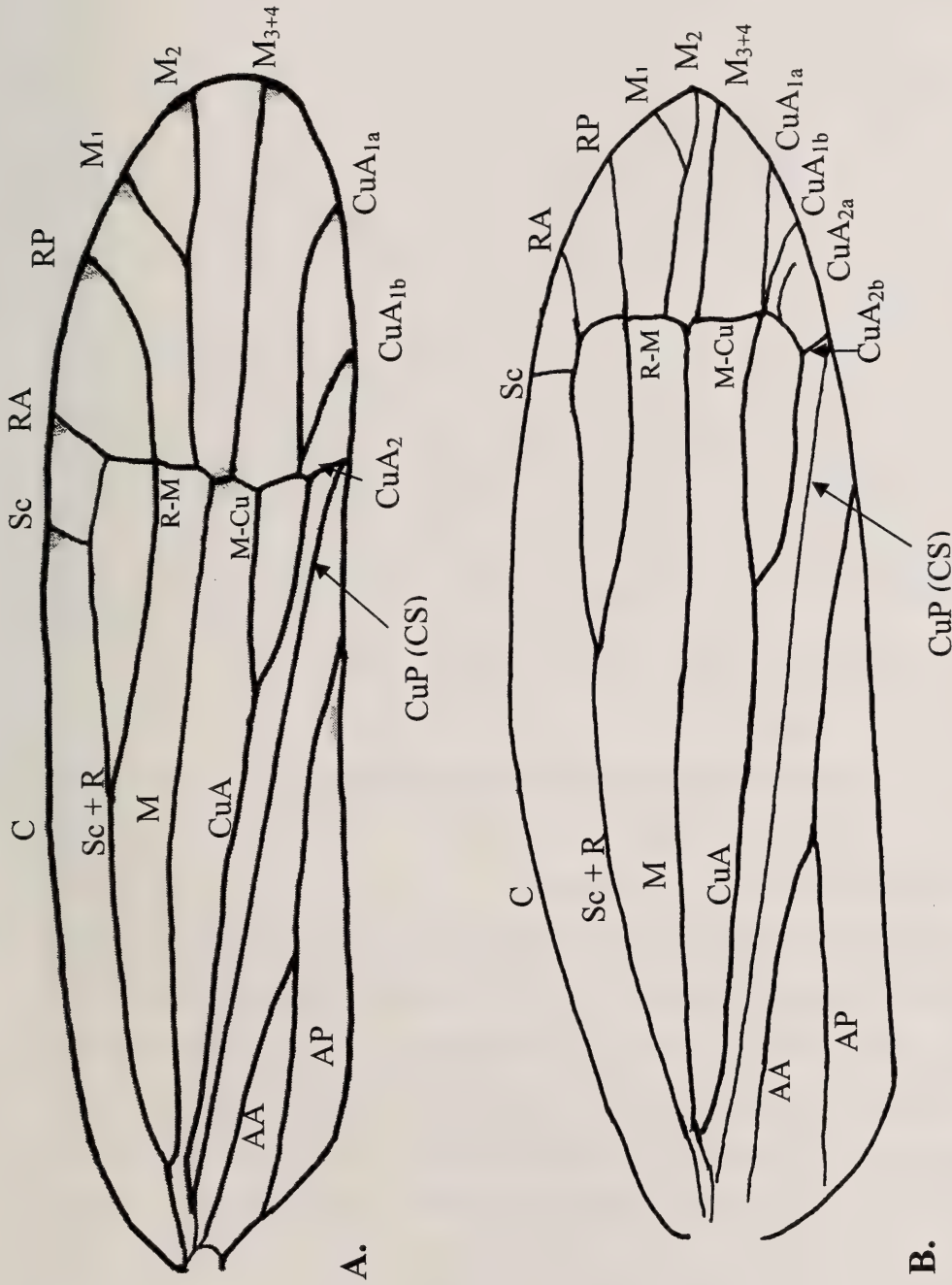


Figure 6. Wing venation following Dworakowska (1988). A. *Kelisicranus arundiniphagus*, B. *Obtusicranus bicarinus*. Abbreviations: AA = Anterior Anal, AP = Posterior Anal, C = Costa, CuA = Anterior Cubitus, CuP = Posterior Cubitus (CS = Claval Suture); M = Media (posterior), RA = Anterior Radius, RP = Posterior Radius; Sc = Subcosta.

Obtusicranus NEW GENUS

Type species. *Obtusicranus bicarinus* n. sp.

Diagnosis. Head produced before eye to nearly width of eye, angle of fastigium blunt. Median carinae of frons paired, subparallel, closely approximate at frontoclypeal suture, slightly diverging nearly to apex before abruptly meeting at fastigium. Calcar thickly foliate, slightly tectiform, subcultrate, with many small, black-tipped teeth on lateral margin. Gonoplasts greatly expanded, wax bearing. Male genitalia with forcepslike parameres. Diaphragm of pygofer well developed, armature absent. Aedeagus long, fine; resting within phallosome posterior to articulation with segment X. Connective between segment X and phallosome without subanal process. Segment X symmetrical, with two paired strong, widely separated processes, one from dorsolateral margins, other directly ventrad of first.

Remarks. This new genus is separated from all other stenocranines by the doubled median carina on the frons. None of the North American *Stenocranus* have their head projected forward to the degree of *Obtusicranus*. The strongly flattened gonoplasts are a feature shared with most North American *Stenocranus*, except *S. similis*. The presence of two pairs of processes on segment X is shared among North American stenocranines only with *Stenocranus arundineus*.

Etymology. The specific name is an arbitrary combination of letters, to be treated as masculine, formed by combining "obtus" (Latin, meaning blunt), with "cranus," the termination of *Stenocranus* (referring to the head, in reference to the rounded apex of the vertex), connected with an "i."

Obtusicranus bicarinus NEW SPECIES

(Figs. 1, 3, 4c,d; 6b)

Type Locality. Arizona, White Mountains.

Diagnosis. Color: General body uniformly light tan; slightly darker on clypeus, ventral most portion of frons, and laterally on nota. Carinae concolorous with body. Legs pale with darker foveae. Tegmina of brachypter clear, veins pale. Some specimens with longitudinal dark bar of varying length following M_{3+4} from wing tip (Fig. 6). Abdominal terga pale laterally and middorsally, with irregular dark midlateral band. Venter of female with segments 4-6 pale laterally, except 3-6 tiny brown spots; brown middorsally, except sclerite margins; gonapophyses light brown. Abdomen of male similar to female; pygofer pale.

Structure: Body length: ♂ 4.13 mm (4.0-4.2, n=4); ♀ 4.78 (4.4-5.0, n=5). Head, including eyes narrower than pronotum (0.82:1) (Fig. 3a). Vertex posteriorly truncate with eyes projecting posteriorly beyond vertex for 0.3 their length. Vertex much longer (0.6 mm) than wide (0.34 mm), projected in front of eye for approximately 0.5x total length. Vertex anteriorly rounded. Lateral carinae of vertex in dorsal view shallowly converging to junction with submedian carinae, slightly diverging before converging to rounded apex. In lateral view, lateral carinae of vertex meeting lateral carinae of frons with acute angle at fastigium; ver-

tex slightly declinate in apical half (Fig. 3c). Angle of fastigium approximately 45° . In dorsal view, median carinae of vertex meeting arms of Y-shaped carina in anterior fifth of eye (Fig. 1). Submedian carinae of vertex raised slightly above level of lateral carinae, intersecting arms of Y-shape carina just anterior to eyes, converging at approximately 40° angle to meet slightly posterior to fastigium. Frons narrow (0.35 mm), and long (0.90 mm); lateral carinae subparallel, widest at ventral margin of eyes (Fig. 3b). Postclypeus and anteclypeus with conspicuous median carinae, together about $2/5$ length of frons. Rostrum short, reaching mesocoxae. Subocular suture conspicuous, slightly curved in dorsal quarter to reach eye just anterior to antennae. Antennae terete, segment I just as long as wide, II $3\times$ length of I. Pronotum in dorsal view approximately half as long as vertex, narrowing anteriorly on posterolateral margins behind eyes, concavely arced between eyes to truncate apex; posterior margin concave between lateral carinae. Pronotal carinae conspicuous, reaching hind margin. Carinae of mesonotum conspicuous; lateral carinae diverging slightly reaching hind margin; median carina obsolete at scutellum. Wings rather pointed apically, row of crossveins in apical $1/4$ (Fig. 6b); CuA_1 and CuA_2 variable in development. Hindwings $0.6\times$ length of forewings in all available specimens. Metatibia with two lateral spines. Metabasitarsus as long as tarsomeres 2 + 3 combined; spinulation of metabasitarsus 7 (2 + 5), 2nd 4. Calcar approximately $0.5\times$ total length of basitarsus, thickly foliate, tectiform, subcultrate, with many (ca. 11-15) small, black-tipped teeth on lateral margin.

Male genitalia with pygofer subtriangular in lateral view, dorsal and caudal sides subequal (Fig. 4c). In caudal view, with slight ridge at opening between lateral margin and diaphragm and small projections on either side of parameres. Diaphragm without armature. Parameres directed caudodorsally, forcepslike, tapering to slightly upturned, acuminate apices; basal angle obtuse (Fig. 4d). Aedeagus fine, sclerotized, somewhat serpentine; partially enclosed within weakly sclerotized phallosome, bearing elongate, caudoventrally directed apex; phallosome approximately half length of segment X. Segment X approximately $0.5\times$ as tall as pygofer, bearing four stout, bilaterally symmetrical processes, subequal in length; two stout processes from dorso-lateral corners, and two broad, strongly flattened, acutely pointed processes ventrad of first. Segment X without subanal process. Anal tube elongate and conspicuous. Female with gonoplares greatly expanded, wax bearing, concealing ovipositor (Fig. 3d).

Remarks. *Stenocranus arundineus* is the only other North American stenocranine with two pairs of processes on segment X, although in that species the ventral processes are longer than the dorsal processes and are not strongly flattened. *Obtusocranus bicarinatus* is the first Stenocranine reported from the southwestern US.

Material Examined. Holotype: "White Mts. Ariz/ VI-19-1950/ R. H. Beamer // ♂ // SEMC //HOLOTYPE/Obtusocranus/bicarinus/Bartlett" (♂, SEMC). Paratypes: ARIZONA: 8 specimens same as holotype (2♂ [one specimen with plesiotype, R. H. Beamer, label], 4♀ SEMC; 1♂, 1♀ UDCC); 1 specimen

Flagstaff, VII-8-41, R. H. Beamer (♀, SEMC). COLORADO: 1 specimen Mesa Verde Nat. Pk., Pinyon Pine-Juniper, C4:6/29/44 (♀, SEMC).

Etymology. The specific name is formed from “bi-” (Latin, two, twice, double) plus “*carin*” (Latin, A keel), referring to the paired carinae of the frons, with the masculine Latin termination “-us”.

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I am indebted to Kimberly Shropshire, who graciously provided the line art for Figure 1, and to William Brown who scanned the art. I thank Lewis Deitz, Matthew Wallace, and two anonymous reviewers for helpful comments on this manuscript. I especially thank Jeanie Hilton of Discover Life in America and Keith Langdon of the National Park Service for the opportunity to conduct research in the Smokies. This research was supported by Discover Life in America, The National Park Service, and the University of Delaware Department of Entomology and Wildlife Ecology.

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AN ANNOTATED CHECKLIST OF THE BLOW FLIES (DIPTERA: CALLIPHORIDAE) OF SOUTH CAROLINA, U.S.A.¹

Kristin D. Cobb² and Will K. Reeves³

ABSTRACT: Calliphoridae are of medical, veterinary, and forensic importance. No statewide checklist of calliphorids exists for South Carolina. Collections of blow flies (Diptera: Calliphoridae) from South Carolina were obtained from beef liver, carrion, feces, the Clemson University Arthropod Collection, and the Georgia Museum of Natural History. Additional records were obtained from published literature. We report collections from 41 of 46 counties in South Carolina. The collections revealed 20 species, representing 11 genera. We report new state records for *Calliphora terraenovae* Macquart from Charleston County, *Chrysomya rufifacies* (Macquart) from Pickens County, *Bufolucilia silvarum* Townsend from Dillon County, and *Opsodexia bicolor* (Coquillett) from Aiken County.

KEY WORDS: Blow fly, Calliphoridae, South Carolina, forensics, carrion

The medical and veterinary importance of blow flies (Diptera: Calliphoridae) is often overlooked, but these flies can be pests of humans and animals. Blow flies are mechanical vectors of various pathogens including those responsible for anthrax, cholera, and diarrhea (Greenberg 1971). An adult calliphorid can harbor an average of 2×10^6 bacteria, including many infectious to humans and animals (Hall 1948). Blow flies are important in forensic entomology because many invade and develop in corpses, making them useful in determining the post-mortem interval (PMI), or time since death.

There are 46 counties in South Carolina and almost all published work involving calliphorids focused on one to three counties surrounding Clemson University. Previous studies of the calliphorid fauna of South Carolina were limited to Pickens County (Payne, 1963; Payne and King, 1972; and Tomberlin and Adler, 1998), or Anderson, Oconee, Orangeburg, and Pickens counties (Tomberlin et al., 2001). We present records from field collections of adult and larval calliphorids and species in the Clemson University Arthropod Collection (CUAC), the Georgia Museum of Natural History (GMNH), and published literature.

METHODS

Aerial hand nets and forceps were used to collect adult or larval flies respectively from beef liver, carrion, and feces in South Carolina. Adults were pinned and larvae were initially placed in boiling water for one minute and then preserved in 80% ethanol. Additional material was obtained from submissions to the Cooperative Extension Service for identification through Clemson University.

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Taxonomic keys used to identify specimens included those by Hall and Townsend (1977), Rognes (1987), Shewell (1987), Sabrosky et al. (1989), and Wells et al. (1999).

ANNOTATED LIST

We obtained specimens from 41 (89%) of 46 counties in South Carolina. The unsampled counties were Berkeley, Chesterfield, Hampton, Jasper, and Marion. A total of 20 species, representing 11 genera were collected and identified. The following checklist is organized by taxonomic group followed by county collection records. Citations follow collection records from published literature. Monthly collection dates were included when available. Classification of calliphorids is based on the catalogs of Hall and Townsend (1977), Rognes (1987), Shewell (1987), and Sabrosky et al. (1989). All taxa are arranged alphabetically. Voucher specimens of all species identified were deposited in the CUAC and GMNH. * = Species previously unreported from South Carolina

Subfamily Calliphorinae

Tribe Angioneurini

Opsodexia Townsend

**bicolor* (Coquillett 1899): Aiken County (April)

grisea Coquillett 1899: Allendale County (Downes, 1986) (June)

Tribe Calliphorini

Calliphora Robineau-Desvoidy

livida Hall 1849: Laurens and Pickens (Payne and King, 1972) Counties (March)

**terraenovae* Macquart 1851: Charleston County (March)

vicina Robineau-Desvoidy 1830: Aiken, Anderson, Charleston, Colleton, Darlington, Dorchester, Edgefield, Florence, Greenville, Greenwood, Lee, Lexington, Marlboro, Oconee (Tomberlin et al., 2001), Pickens (Payne and King, 1972), Richland, Spartanburg, and Union Counties (January-December)

vomitaria (Linnaeus 1758): Fairfield, Florence, Greenville, Laurens, Oconee, Pickens (Payne and King, 1972), Spartanburg, and Williamsburg Counties (January-May)

Cynomyopsis (Robineau-Desvoidy)

cadaverina (Robineau-Desvoidy 1830): Dorchester, Fairfield, Florence, Oconee, Pickens (Payne and King, 1972), and Saluda Counties (March and October)

Tribe Luciliini

Bufolucilia Townsend

**silvarum* (Meigen 1826): Dillon County (June)

Lucilia Robineau-Desvoidy

illustris (Meigen 1826): Aiken, Anderson, Horry, Kershaw, Lexington, Oconee, and Pickens Counties (March-April)

Phaenicia Robineau-Desvoidy

cluvia (Walker 1849): Abbeville, Anderson, Cherokee, Florence, Greenville, Laurens, Oconee, Pickens, and Spartanburg Counties (April-May and September-November)

coeruleiviridis (Macquart 1955): Abbeville, Anderson, Aiken, Cherokee, Dillon, Florence, Greenville, Lancaster, Laurens, McCormick, Oconee, Pickens (Payne and King, 1972), Richland, Spartanburg, and York Counties (April-October)

cuprina (Wiedemann 1830): Anderson, Oconee, Pickens (Payne and King, 1972), and Sumter Counties (September-October)

sericata (Meigen 1826): Anderson, Barnwell, Beaufort, Calhoun, Cherokee, Colleton, Florence, Greenville, Greenwood, Lexington, Newberry, Oconee (Tomberlin et al., 2001), Pickens (Payne and King, 1972), and Spartanburg Counties (March-November)

Tribe Phormiini*Phormia* Robineau-Desvoidy

regina (Meigen 1826): Abbeville, Allendale, Anderson (Tomberlin et al., 2001), Bamberg, Calhoun, Charleston, Chester, Clarendon, Colleton, Dorchester, Edgefield, Fairfield, Florence, Georgetown, Greenville, Greenwood, Lexington, McCormick, Newberry, Oconee (Tomberlin et al., 2001), Orangeburg, Pickens (Payne and King, 1972), Union, Williamsburg, and York Counties (January-December)

Protocalliphora

braueri (Hendel 1901): Pickens County (Whitworth, 2003) (July)

deceptor Sabrosky, Bennett, and Whitworth: Aiken 1989 (Sabrosky et al., 1989) and Pickens County (May)

Subfamily Chrysomyiinae**Tribe Chrysomyiini***Cochliomyia* Townsend

hominivorax (Coquerel 1858): Allendale (Sept 1964), Dorchester (Oct 1939), and Pickens (Aug 1956) Counties. Dates are included for *C. hominivorax* because it was eradicated from the state in the 1950s (Goddard and Lago 1983) (September-October)

macellaria (Fabricius 1775): Abbeville, Aiken, Anderson (Tomberlin et al., 2001), Charleston, Florence, McCormick, Newberry, Orangeburg, Pickens (Payne and King, 1972), and Richland Counties (March-December)

Chrysomya Robineau-Desvoidy**rufifacies* (Macquart 1843): Pickens County (September)

Subfamily Polleniinae

Tribe Polleniini

Pollenia Robineau-Desvoidy*rudis* (Fabricius 1794) Pickens County (Newman and Carner, 1975) (February)

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DISTRIBUTION AND HABITAT CHARACTERISTICS OF THE COLOR POLYMORPHIC BUSH-CRICKET *ISOPHYA RIZEENSIS* SEVGILI (ORTHOPTERA: TETTIGONIIDAE: PHANEROPTERINAE) IN TURKEY¹

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ABSTRACT: *Isophya rizeensis* Sevgili, 2003 (Orthoptera: Tettigoniidae: Phaneropterinae) is endemic to the Firtina Valley in the northeast of Turkey. This paper describes the spatial distribution and habitat characteristics of nymphs and adults of *I. rizeensis* within the Firtina Valley taking color variation into consideration. Both male and female color morphs showed marked differences in spatial distribution with dark morphs appearing in the lowlands (between 300-1000 m) and light morphs appearing in the highlands (between 1000-2000 m). Both development stages (nymphs and adults) were found only in forb/herb and shrub vegetation within certain open habitat patches along the Firtina Valley. Microclimatic and vegetative properties of different habitat patches and behavioral differences of *I. rizeensis* in these different patches were also evaluated. Factors responsible for the differential distribution of color morphs were discussed in relation to characteristics of local habitat patches.

KEY WORDS: *Isophya rizeensis*, Orthoptera, Tettigoniidae, Phaneropterinae, habitat characteristics, color polymorphism, distribution, Firtina Valley, Turkey

The bush cricket *Isophya rizeensis* is a newly described species (Sevgili, 2003) found in the North-East Mountain Ranges of Turkey. It is endemic to Anatolia and has a very restricted distribution (Sevgili, 2003; Sevgili, 2004). The most striking feature of this species is the high variability of dorsal and ventral coloration, a feature which is most apparent in males. Moreover this variation in coloration is reported to have a spatial pattern with black color morphs appearing in lowlands (600-1000 m altitudes) and yellowish-green color morphs appearing in the subalpine zones of the Kaçkar Mountains (Sevgili, 2003; Sağlam, 2004).

Coloration is one of the most important defensive attributes of bush-crickets. Bush-crickets tend to specialize in blending into the background on which they rest remaining motionless during daylight hours (Gwynne, 2001). As noted by Gwynne (2001) "usually all or most activity occurs at night thereby reducing the risk of being spotted by visually hunting mammals and birds, groups that probably have had a long selective influence on bush-crickets." That color pattern contributes to individual variation in susceptibility to visually oriented predators has been demonstrated by many researchers for orthopterans (Forsman and Appelqvist 1998, 1999) and other ectotherms (Brodie, 1992; Endler, 1991, 1995; Forsman and Shine 1995; Kingsolver, 1995, 1996). Furthermore in environments where animals cannot easily attain high body temperatures one may expect properties such as coloration which affects heating rates and equilibrium body temperatures (Forsman 1995, 1997; deJong et al., 1996) to translate into differential

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fitness since many characteristics of such animals are heavily dependent on body temperature including growth (Stevenson et al., 1985), egg production (Forsman 1999a), behavior (Forsman, 2000), mating success (Willmer 1991) and performance (Harrison et al., 1991; Forsman 1999b; Gilchrist 1996).

Apart from properties of the individual like coloration, important fitness determinants such as body temperature and survival are heavily dependant on habitat. Bush-crickets are classical heliotherms using behavioral mechanisms to maintain high diurnal body temperatures (Chappell and Whitmann, 1990). Thus, in warm ambient temperatures, crickets may move lower in the vegetation to be shaded by plants, whereas in cooler environments they may move up in the vegetation to gain heat (Harrison and Fewell 1995). In addition, orthopterans may experience different levels of predation risk at different heights in the vegetation. Crickets may move lower in the vegetation to escape aerial predation or higher to escape ground predators (Pitt, 1999). Furthermore population characteristics like size, sex, diapause duration, development time and survival can all differ in relation to humidity, temperature and vegetative features of the habitat (Monk, 1985; Atkinson and Begon 1987a, 1987b; Sibly and Monk, 1987; Dingle et al., 1990; Thorens, 1991; Telfer and Hassal, 1999; Szovenyi, 2002).

Therefore structural characteristics, vegetation composition, and microclimatic properties of the available habitats and color pattern of individuals can greatly influence the distribution of orthopterans at regional and local scales. Currently, there is no data available on the habitat characteristics of *I. rizeensis* and no comparative studies between color morphs have been conducted. In the present study, we describe the spatial distribution and habitat characteristics of *I. rizeensis* taking different color morphs into consideration. Our main objective is to determine the factors responsible for the observed spatial pattern and whether different color morphs inhabit different habitats under different ecological, hence potentially different selective pressures. In addition, a thorough description of the color morphs will be given since no such proper description has been published.

METHODS

The Species

Isophya rizeensis is a large (17.7-25 mm) flightless ground-living bush cricket. Nymphs emerge in late May and early June and adults are found from late June to the end of August. At higher altitudes (over 1500 m) nymph emergence shifts towards the middle of June and first adults are seen starting from the second week of July (Sağlam, 2004). The species mainly feeds on herbs and grasses situated in the bottom of the vegetation and feeding and mating activity usually occurs at night. *Isophya rizeensis* occurs syntopically with other bush-crickets such as *Poecilimon schmidtii* (Fieber, 1853), *P. similis* (Retowski, 1889), *Phonochorion* spp. and *Pholidoptera griseoaptera* (DeGeer, 1773) in the lowlands and with *Psorodonotus specularis* (Fischer de Waldheim, 1846) and *Phonochorion* spp. in the subalpine and alpine zones of the Kaçkar Mountains (Sevgili, 2003).

According to the only previous study published (Sevgili, 2003) the species is distributed along the “Fırtına Valley” situated in the East Black Sea region of Turkey; ranging from the northern slopes of the Kaçkar mountains to the low-lands of Çamlıhemşin town in the Rize Province (Figure 1).

Color Morphs

Like most species within the genus *Isophya*, *I. rizeensis* is polymorphic for color pattern. Males can be classified into three distinct morphs according to color pattern (Sağlam, 2004): 1) Black morphs: dorsal surface of abdomen totally black except for two red longitudinal bands, ventral surface of abdomen red or yellow, tegmina claret red in subcoastal and radial areas; 2) Brown morphs: dorsal surface of abdomen brownish yellow, ventral surface yellow, tegmina same as black morph; 3) Light green morphs: dorsal surface of abdomen light green with two distinct yellow longitudinal bands, ventral surface yellow, tegmina same as other morphs. Similar variation in color patterns is seen in females but is not as distinct as those in males therefore females were classified separately with green being the dominant color morph (Sağlam, 2004): 1) Dark green morphs: dorsal surface of abdomen dark green with rare black markings, ventral surface yellow; 2) Black morphs: dorsal surface of abdomen black, ventral surface claret red; 3) Light green morphs: dorsal surface of abdomen light green with two distinct yellow longitudinal bands, ventral surface yellow.



Fig. 1. Map of distributional area of *Isophya rizeensis* within the black sea region of Turkey. Shaded area indicates the total range of the species (Sevgili, 2003).

Study Area

The study was conducted in the Fırtına Valley stretching from the lowlands of Çamlıhemşin town (N 41 02.242 / E 41 00.501, 353 m) up to the highlands of Elevit Plateau (N 40 51.288 / E 41 00.750, 1890 m) (Fig. 1). The valley is covered with warm-deciduous forests existing without interruption since the Tertiary and harbors many distinct habitats such as alluvial stream forests, beech forests, boxwood forests and meadows in the lowlands and pine forests, subalpine meadows and grasslands in the highlands near the slopes of the Kaçkar Mountains (Güner et al., 1987). The valley is surrounded by dense tree lines reaching over 30 meters from all sides isolating the valley from wind currents therefore wind activity within the valley is highly reduced. The valley receives abundant rainfall all year long with mean precipitation values reaching 1296.5 mm. Temperatures are usually low with a yearly mean of 13.5°C. Highest temperatures are recorded in July and August with mean values around 21.7°C but temperatures within the day can vary greatly depending on sunlight and rainfall. Relative humidity is high and constant throughout the year with mean values around 73-82% RH. Fog formation is common in the area especially at higher altitudes where fog tides come and go on a daily basis. Since all prior records of the species were given from the Fırtına Valley, our study mainly focused on this area while excursions were made to neighboring regions in order to determine the total range of the species.

Field Work, Sampling Procedure and Analyses

Field surveys were conducted systematically six times between June-September 2003. All suitable habitat patches were visited in order to determine the presence or absence of *I. rizeensis*. Presence of *I. rizeensis* was determined through its characteristic stridulation (Sevgili, 2003) and observation of adults and nymphs. In cases where no specimens were observed and no stridulation heard, the localities were consistently rechecked.

Habitat characteristics and distribution of color morphs were evaluated by studying 13 habitat patches at varying altitudes where the presence of *I. rizeensis* was determined (Table 1). Relative size of habitat patches varied between 20 m² to 50 m² as these were usually forest clearings exposed to the sun. To quantify the microclimatic conditions of each habitat patch, we measured temperatures and relative humidity in vegetation using a thermo-hygrometer penetration probe (Hanna model, HL8564). Wind measurements were left out since no wind activity was ever noted in any of habitat patches except for habitat patch 13, and even here wind speeds never exceeded 2 knots. Meteorological data from the nearby weather station situated in the town of Pazar was not used since climatic properties of the valley appeared to be greatly independent from the local weather (Sağlam, 2004).

Sampling was conducted during the day between 11:00 am and 18:00 pm when the majority of males call consistently and most individuals actively thermoregulate optimizing our chances of spotting individuals and giving more reliable estimate of color morphs frequencies. *Isophya rizeensis* populations were

monitored by counting all nymphs, males and females systematically by walking in straight lines spaced at two meters. During monitoring, the vegetation type from which each specimen was recorded was determined. In addition, the color pattern of all sighted specimens and their relative position in the vegetation was recorded in order to have an idea about behavioral differences brought on by predation and thermal requirements. Crickets were classified as on top, in the middle or below the vegetation in order to remove the bias that could originate due to differences in vegetation height between habitat patches.

Plant species composition and abundance in the 13 habitat patches were determined following Braun-Blanquet's method (Akman et al., 2000). Vegetation structure of the habitat patches were determined by sorting identified plant species into structural categories. Habitat characteristics of *I. rizeensis* was determined by testing whether the distribution of the species among the vegetation categories differs significantly from a random distribution. Deviation from a random distribution was tested using the Chi-square Goodness of Fit test. In addition, to test for differences in habitat preferences between males, females and nymphs, the Chi-square test was employed for the observed and expected frequencies of male, female and nymphs on different plant associations.

RESULTS

Distribution

As in Sevgili (2003), no specimens were ever observed outside the Firtina Valley. First sighting of individuals were recorded at 353 m near the town of Çamlıhemşin and subsequent sightings were made at 12 other sites at differing altitudes along the valley (Table 1). The highest altitude which *I. rizeensis* was collected from was the Elevit Plateau situated 1890 meter. No specimens were found at higher altitudes. The distribution pattern of *I. rizeensis* along the Firtina Valley was not continuous but showed a patchy pattern with individuals located in certain open habitats usually separated by 1-2 km.

Distribution of Color Morphs

Distribution of both male and female color morphs showed a discrete spatial pattern. In both sexes darker morphs were found at lower altitudes. Counts of male and female color morphs from different habitat patches are given in Fig. 2A and 2B respectively.

In males black morphs were mostly distributed in habitat patches between 300 m – 1000 m altitude and no specimens belonging to other color morphs were recorded from these altitudes. Similarly green color morphs were recorded only from habitat patches between 1000 m – 1900 m altitude. A small number of black morphs were also recorded from these altitudes but except for habitat patch 9 at 1246 m altitude the number of counts was negligible (Figure 2A). Brown color morphs were recorded only between 1000 m – 1100 m altitude from habitat patch 8 along with a respectable number of green morphs. Although the number of black morphs collected from this patch was extremely low (n=5), habitat patch 8 was the only habitat where all color morphs were seen (Fig. 2A).

Table 1. Altitude and coordinates of the 13 habitat patches where the presence of *I. rizeensis* has been determined.

Sites	Altitude	Coordinates
Habitat Patch 1	352.7 m	N 41° 02' 14.9" E 41° 00' 29.9"
Habitat Patch 2	420.6 m	N 41° 00' 19.6" E 40° 59' 20.4"
Habitat Patch 3	442.9 m	N 40° 59' 46.8" E 40° 58' 29.4"
Habitat Patch 4	475.2 m	N 40° 59' 08.2" E 40° 57' 52.5"
Habitat Patch 5	665.1 m	N 40° 56' 24.2" E 40° 58' 04.6"
Habitat Patch 6	883.1 m	N 40° 54' 59.8" E 40° 56' 44.2"
Habitat Patch 7	979.9 m	N 40° 54' 27.1" E 40° 56' 52.5"
Habitat Patch 8	1028.0 m	N 40° 53' 16.6" E 40° 55' 47.0"
Habitat Patch 9	1246.3 m	N 40° 51' 46.7" E 40° 56' 05.1"
Habitat Patch 10	1335.6 m	N 40° 51' 49.2" E 40° 57' 08.9"
Habitat Patch 11	1485.6 m	N 40° 51' 46.7" E 40° 58' 11.3"
Habitat Patch 12	1621.4 m	N 40° 51' 58.3" E 40° 59' 05.2"
Habitat Patch 13	1893.9 m	N 40° 51' 17.4" E 41° 00' 45.1"

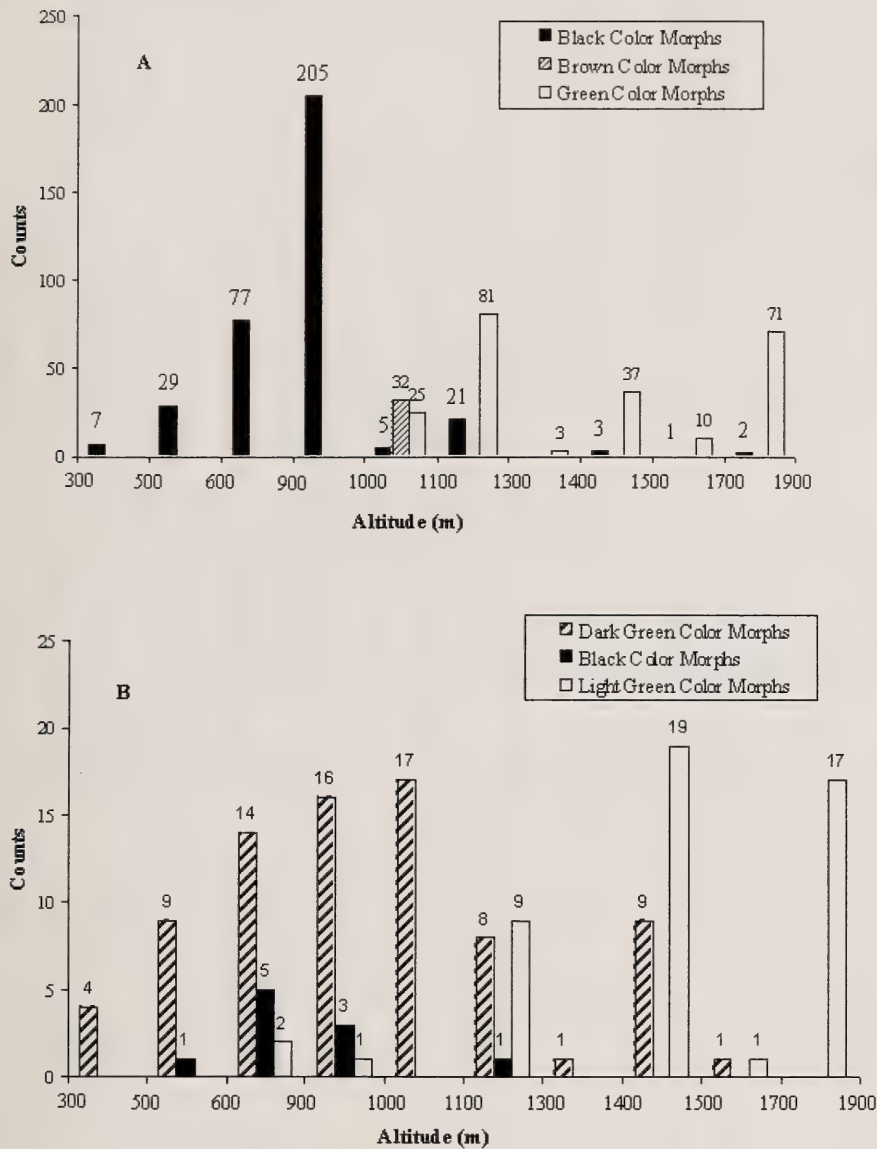


Fig. 2. Distribution of male (A) and female (B) color morphs of *I. rizeensis* in habitat patches at different altitudes within the Firtina Valley.

Female color morphs showed similar spatial variation but the pattern was not as distinct as those in males. Dark green morphs were found to be distributed between 350 m – 1600 m altitude but average numbers dropped from 14 individuals per patch to 6 individuals per patch over 1100 m altitude (Figure 2B). Distribution of light green morphs ranged between 800 m – 1900 m altitude, but high number of light green morphs were found only in habitat patches at higher altitudes over 1400 m (Figure 2B). Only a small number of female black color morphs

Table 2. Classification of open habitats where the presence of *I. rizeensis* has been recorded. Total number of plant species, % of forb/herb, shrub, graminoid (dense and tall grasses) and tree species and dominating plant species in each open habitat patch are mentioned.

Habitat Patch	Number of Species	% Species			Species with highest "cover-abundance" values	
		Forb/herb	Shrub	Graminoid	Tree	
1	24	70.84	12.55	4.16	12.5	<i>Sambucus nigra</i> L. (Caprifoliaceae) (1), <i>Plantago lanceolata</i> L. (Olanaginaceae) (1), <i>Alnus glutinosa</i> (L.) Gaertn. (Betulaceae) (1)
2	16	68.75	6.95	5.55	18.75	<i>Pteridium aquilinum</i> (L.) Kuhn, (Dennstaedtiaceae) (2)
3	13	53.85	15.38	7.69	23.08	<i>Sambucus nigra</i> L. (Caprifoliaceae) (1), <i>Rubus ideaus</i> L. (Rosaceae) (1)
4	16	56.25	18.75	6.25	18.75	<i>Sambucus nigra</i> L. (Caprifoliaceae) (1) <i>Rubus ideaus</i> L. (Rosaceae) (1)
5	15	56.33	13.33	6.66	23.68	<i>Salvia verticillata</i> L. (Lamiaceae) (1) <i>Plantago lanceolata</i> L. (Plantaginaceae) (1)
6	10	80.00	20.00	-	-	<i>Urtica dioica</i> L. (Urticaceae) (3)
7	21	71.43	23.81	-	4.76	<i>Pteridium aquilinum</i> (L.) Kuhn (Dennstaedtiaceae) (4) <i>Alchemilla retineruis</i> Buser (Rosaceae) (4)
8	17	70.59	11.76	-	17.65	<i>Coryllus avellana</i> L. (Corylaceae) (1)
9	27	66.39	25.93	.	7.41	<i>Alchemilla retineruis</i> Buser (Rosaceae) (4) <i>Sambucus nigra</i> L. (Caprifoliaceae) (3)
10	21	71.43	19.05	4.76	4.76	<i>Sambucus nigra</i> L. (Caprifoliaceae) (3)
11	34	73.53	17.65	5.88	2.94	<i>Delphinium formosum</i> Boiss (Ranunculaceae) (1)
12	29	68.96	10.35	17.24	3.45	<i>Alchemilla caucasica</i> Buser (Rosaceae) (3) <i>Rhododendron ponticum</i> L. (Ericaceae) (1)
13	35	74.28	11.43	14.29	0	<i>Alchemilla caucasica</i> Buser (Rosaceae) (4), <i>Alchemilla mollis</i> (Buser) Pothm (Rosaceae) (1)

were recorded from habitat patches between 500 m – 1300 m altitude and no such specimens were collected from habitat patches at higher altitudes (Figure 2B).

Habitat Characteristics

The presence of *I. rizeensis* was determined in 13 habitat patches along the Firtina Valley. All were open habitats (forest clearings) exposed to the sun. No specimens were ever found in any type of forest. Vegetation structure of the 13 habitat patches is given in Table 2. All 13 patches consisted mainly of three structurally different vegetation types; forb/herb, shrub and graminoid (dense and tall grasses). No specimens were found in other open habitat types in the area, such as meadows or lawns. The frequency with which *I. rizeensis* was recorded from plant species belonging to each vegetation type within the 13 patches was recorded (Table 3). The hypothesis that individuals were distributed among the vegetation types at random was tested using the Chi-square Goodness of Fit test. The null hypothesis was rejected in each case (male nymphs $X^2 = 213.50$, $df = 8$, $p < 0.001$; female nymphs $X^2 = 58.32$, $df = 8$, $p < 0.001$; male adults $X^2 = 234.48$, $df = 8$, $p < 0.001$; female adults $X^2 = 87.55$, $df = 8$, $p < 0.001$). Results show *I. rizeensis* individuals were not distributed among the three vegetation types at random, but were more frequently associated with shrub habitats and were rare in dense and tall grasses.

To test whether the distribution of the sexes and development stages in Table 3 differed statistically, the Chi-square test was employed. Males and females differed significantly ($X^2 = 53.947$, $df = 8$, $p < 0.001$) in the types of vegetation they were seen to occupy. This difference was mainly due to the preference of females for more open vegetation as can be inferred from their lack of presence in more dense and closed vegetation such as *Rubus* (Rosaceae) associations. Both females and males showed significant difference in use of vegetation types between the two stages ($X^2 = 36.471$, $df = 8$, $p < 0.001$; $X^2 = 117.307$, $df = 8$, $p < 0.001$). Both underwent a change in behavior on becoming adults and were found in taller and denser shrub associations when compared with the nymphs of the same sex.

Differences Between Sites

Microclimate

Microclimatic properties of the habitat patches changed as expected with ambient temperatures decreasing with higher altitude. The habitat patches can be classified into two groups according to microclimate with habitat patches 1 through 7 constituting the relatively warm environment and habitat patches 8 through 13 constituting the relatively cooler environments. Mean in vegetation temperatures changed from $21.63^\circ\text{C} \pm 0.50$ to $17.83^\circ\text{C} \pm 0.96$ from habitat patches 8 and higher. Soil temperatures showed a similar change with mean temperatures dropping from $21.00^\circ\text{C} \pm 0.82$ to $16.65^\circ\text{C} \pm 1.70$ from habitat patch 8 and higher. Moreover this difference was statistically significant (vegetation $H = 22.73$, $df = 1$, $p < 0.001$; soil $H = 7.50$, $df = 1$, $p = 0.006$) as show by non-parametric Kruskal-Wallis test.

Table 3. Percentage of nymph and adult *I. rizeensis* associated with plant species belonging to shrub, forb/herb and graminoid vegetation type in the 13 habitat patches at different altitudes within the Firtuna Valley. Height profile of plant species belonging to each vegetation type are also given.

Plant Species	Height Profile (cm)	Nymph (n=353)	Adult Male (n=608)	Adult Female (n=136)
Shrubs				
<i>Rhododendron ponticum</i> L. (Ericaceae)	150-180	4%	13%	15%
<i>Rubus ideaus</i> L. (Rosaceae)	90-110	10%	27%	5%
<i>Sambucus nigra</i> L. (Caprifoliaceae)	100-160	29%	18%	35%
<i>Coryllus avellana</i> L. (Corylaceae)	180-200	0	8%	7%
Forb/herbs				
<i>Urtica dioica</i> L. (Urticaceae)	50-90	23%	13%	6%
<i>Salvia verticillata</i> L. (Lamiaceae)	30-40	23%	6%	11%
<i>Rumex scutatus</i> L. (Polygonaceae)	30-40	4%	5%	10%
<i>Pteridium aquilinum</i> (L.) Kuhn (Dennstaedtiaceae)	90-160	4%	7%	4%
Graminoid	≤30 cm	3%	3%	7%

Vegetative Features

Bush-Crickets were found to be associated with different forb/herb and shrub species providing different levels of coverage in habitat patches at different altitudes. Bush-Crickets recorded from habitat patches between 300 m – 1000 m altitude (black morphs) were mostly associated with the densely packed dwarf shrub *Rubus ideaus* L. (Rosaceae) providing high levels of cover. In comparison bush-crickets distributed in habitat patches located at higher altitudes between 1000 m – 1500 m were mostly associated with taller tree-shrubs like *Coryllus avellana* L. (Corylaceae) (1000 m – 1100 m altitude; brown morphs), *Sambucus nigra* L. (Caprifoliaceae) (1200 m – 1500 m altitude; green morphs), and *Rhododendron ponticum* L. (Ericaceae) (1500 m – 1900 m altitude; green morphs) with relatively much reduced levels of cover (Table 4).

Table 4. Vegetation usage profile of adult *Isophya rizeensis* in habitat patches at different altitudes within the Firtina Valley. Plant species belonging to each vegetation type and their height profile are given.

Plant Species	Height Profile (cm)	Altitude (m)			
		350-1000 (n=373)	1000-1100 (n=80)	1100-1500 (n=192)	1500-1900 (n=103)
Shrubs					
<i>Rhododendron ponticum</i> L. (Ericaceae)	150-180	—	—	6%	85%
<i>Rubus ideaus</i> L. (Rosaceae)	90-110	44%	—	—	11%
<i>Sambucus nigra</i> L. (Caprifoliaceae)	100-160	10%	13%	55%	—
<i>Coryllus avellana</i> L. (Corylaceae)	180-200	—	46%	11%	—
Forb/herbs					
<i>Urtica dioica</i> L. (Urticaceae)	50-90	12%	6%	22%	1%
<i>Salvia verticillata</i> L. (Lamiaceae)	30-40	9%	20%	3%	—
<i>Rumex scutatus</i> L. (Polygonaceae)	30-40	10%	—	—	—
<i>Pteridium aquilinum</i> (L.) Kuhn (Dennstaedtiaceae)	90-160	11%	1%	1%	3%
Graminoid	≤30 cm	4%	14%	2%	—

Behavior

Bush-crickets were found at different heights in the vegetation in habitat patches located at different altitudes (Figure 3). Only habitat patches where the total number of counts exceeded 30 were included in the analysis and female and male counts were pooled due to low number of female counts in habitat patches. Crickets were mostly clustered on top of the vegetation in habitat patches between 600 m – 1000 m altitude, while they were mostly found in the middle of the vegetation in habitat patches between 1000 m – 1900 m altitude (Figure 3). Chi-square analysis showed that this variation between sites was statistically significant ($X^2 = 162.119$, $df = 12$, $p < 0.001$).

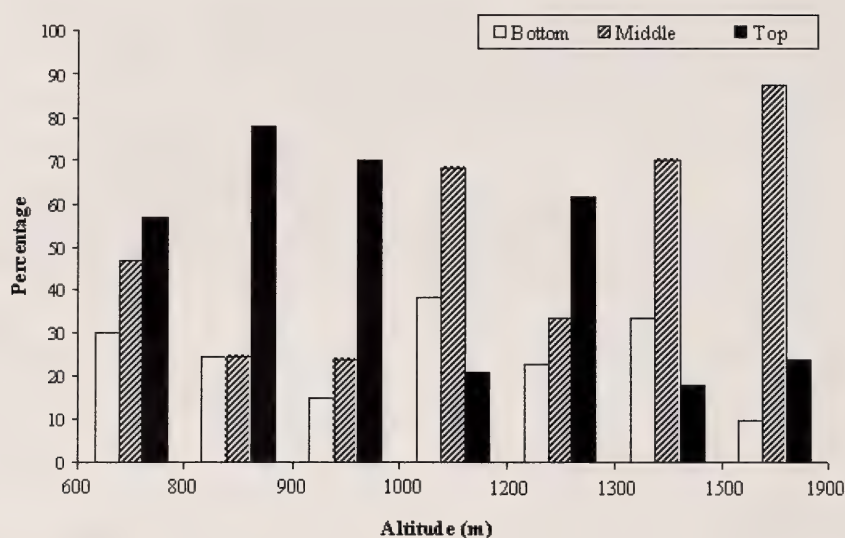


Fig. 3. Relative position (bottom, middle, top) at which crickets were found in the vegetation in habitat patches at different altitudes within the Firtina Valley.

DISCUSSION

Habitat Characteristics

The overall distribution of *I. rizeensis* in the Firtina Valley was not continuous, but showed a fragmented spatial pattern with the species appearing only in certain open habitat patches. On a large scale the presence of *I. rizeensis* was highly correlated with habitats containing forb/herb and shrub vegetation. No specimens were recorded from other open habitats in the area such as meadows or lawns. On a smaller scale although shrub vegetation covered approximately 10-25% of the area of the habitat patches (Table 2) it yielded 66% and 63% of all direct observations of adult males and females respectively (Table 3). The taller vegetation may have a preferred microclimate, a greater abundance of food or provided shelter from predators. Sunlight is extremely limited in the area due to high levels of precipitation and fog. Hence, *I. rizeensis* would be expected to prefer shorter and more open vegetation where it can receive more direct sunlight. Therefore shrub vegetation is unlikely to be selected for its microclimate. Similarly, diet also cannot explain this distribution since the leaves of most shrubs in the area are not edible. Evidence that predation may be important is persuasive. Shrub vegetation provides good shelter for these crickets whose only defense is camouflage and remaining motionless. Furthermore, the dense understory of shrub vegetation is ideal for disappearing for adults of either sex which jump down to the base of the vegetation when approached more than two meters.

Unlike adults, nymphs did not show a preference between either vegetation types and were recorded from both forb/herb (54%) and shrub vegetation (44%) but avoided *Rhododendron ponticum* L. and *Rubus ideaus* L. associations (Table 3). This could result from the disproportionate mortality of eggs and nymphs

below dense vegetation (Cherrill and Brown, 1990; Ingrish, 1984) or maternal oviposition behavior of females which avoid such unfavorable environments. The lack of female bush-crickets from dense *Rubus ideaus* L associations (Table 3) might give support for this hypothesis. Alternatively nymphs could actively avoid these habitats due to elevated risks of size or stage-based and predation caused by spiders (Schmitz et al., 1997; Schmitz, 1998) which are readily found on both *Rubus* and *Rhododendron* associations and by other crickets such as *Psorodonotus specularisa* Fischer-Waldheim, and *Pholidoptera griseoptera* DeGeer found in similar habitats.

Distribution of color morphs

The data presented here indicates that the distribution of both male and female color morphs showed a discrete spatial pattern. In both sexes darker color morphs were mostly predominant in warmer habitats below 1028 m while lighter color morphs were predominant in cooler habitats situated above 1028m (Fig. 2A, B). This is in contradiction to most data showing that insects living in cooler environments are usually darker than their counterparts living in warmer environments (Chapman, 1998). In species that are polymorphic for dorsal color pattern, individuals belonging to dark morphs generally warm up more rapidly and attain higher body temperatures, compared to lighter individuals (Forsman, 1995, 1997; Jong et al., 1996). This would suggest a selective advantage for darker coloration in such environments unless there are other selective agents at work.

Recent studies conducted with color polymorphic organisms state the importance of predation in the maintenance of such variation (Forsman and Appelqvist 1998; 1999; Forsman 1999b). Field data based on behavioral differences among crickets suggests that there could be different predation pressures in habitat patches at different altitudes. Vertical distribution of bush-crickets in the vegetation is effected mainly by temperature (Harrison and Fewell 1995), wind (Anderson and Abramsky, 1979; Chappell, 1983) and predation (Pitt 1999). In environments with limited radiative regimes, bush crickets would normally be expected to be found higher in the vegetation increasing their exposure to direct solar radiation (Pitt, 1999). In line with this, as expected, *I. rizeensis* individuals in habitat patches at lower altitudes (below 1028m) were found mostly on top of the vegetation whereas individuals in habitat patches at higher altitudes over 1028 m were found lower in the vegetation (Fig. 4). Cool wind currents are usually effective at highlands and could force bush-crickets into lower more protective regions of the vegetation. Since wind currents in the area are almost negligible, this factor seems unlikely to explain the observed pattern. Habitats at higher altitudes provide less coverage increasing the susceptibility of individuals to predation. Predation pressures caused by visually guided predators, such as birds could force these individuals into lower levels of the vegetation (Pitt, 1999) and could explain the observed pattern.

Under conditions with elevated risk from predators, selection might favor the more cryptic light-green color morphs over the black color form. Habitats at lower altitudes were denser and provided higher cover than habitats at higher altitudes. Therefore black coloration would not necessarily result in a cryptic disadvantage under these conditions enabling individuals to utilize the thermal advan-

tages of black coloration. In males a certain amount of black morphs were also sampled from habitat patches at higher altitudes (Figure 2A), whereas no record of lighter morphs at lower altitudes was found. This might suggest that, given the chance, crickets at higher altitudes would use the benefits of darker coloration, but cannot do so since they are actively selected against. The only habitat patch at higher altitudes which yielded a substantial number of black male morphs was habitat patch 8 between 1100 m -1300 m altitude. Interestingly individuals in this habitat were mostly found on top of the vegetation giving some support for this hypothesis.

Predation could also explain why the nature of the color variation and the distribution pattern of female color morphs were less pronounced than in males. Female crickets spend most of their time in the understory of the vegetation searching for suitable oviposition sites and do not actively call out for males therefore are less susceptible to predators (Belovsky et al., 1990). Hence the selective pressure caused by predation on females would be much reduced when compared to males.

However the dynamics of the region are extremely complex. This is especially true for weather patterns which are highly stochastic. The coming and going of heavy fog, constant rains interrupted by short periods of sunlight continually change temperatures and other microclimatic conditions this species is subjected to. Therefore determining the factors resulting in the observed variation is highly difficult and is unlikely to be related only to predation. More data on the thermal preferences and capacity, behavior and life history traits of different color morphs and a better understanding of the selective agents at work in the field is needed in order to fully understand the nature of this variation. Currently, research on these topics is underway and will be reported in the future.

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FIRST RECORD OF THE GENUS *ANABASIS* HEINRICH FROM CHINA, WITH DESCRIPTION OF A NEW SPECIES (LEPIDOPTERA: PYRALIDAE: PHYCITINAE)

Yanli Du,² Shimei Song,³ and Chunsheng Wu⁴

ABSTRACT: *Anabasis* Heinrich is reported for the first time from China. The type species of *Anabasis*, *A. ochrodesma* Heinrich, is from southeastern U.S. From China we describe a species new to science, *A. fusciflavida* sp. n., and transfer *A. infusella* (Meyrick, 1879) from *Copamyntis* Meyrick, a new distribution record for China. A key to Chinese species of *Anabasis* is provided. Adults and genitalia are illustrated.

KEY WORDS: Lepidoptera, Pyralidae, *Anabasis*, China, new species, new combination

Anabasis Heinrich (1956) was erected for the New World species *A. ochrodesma* Zeller that was thought to be closely related to *Acrobasis* Zeller (Heinrich, 1956, p. 25; Neunzig, 1986, p. 71). *Anabasis* was previously only known to occur in southeastern United States and, according to Neunzig (1986), the range of the type species, *A. ochrodesma* (Zeller), extends from southern Florida and South Carolina in the U.S.A. to northern South America. Up to now, *Anabasis* has remained monotypic and restricted to the New World.

In the present paper, this genus is recorded for the first time from China. We describe a new species, *A. fusciflavida*, and create one new combination, *A. infusella* (Meyrick), which is a new distribution record for China. Also, we provide a detailed redescription of *A. infusella* and illustrate its genitalia. Both *A. fusciflavida* and *A. infusella* are limited to southern China.

Anabasis is characterized by having forewings with an antemedial scale ridge, the base of M_2 and M_3 approximate for a very short distance, hindwings with basal half of M_2 and M_3 approximate or anastomosed (Fig. 1), and male genitalia with a transverse, sclerotized ridge from the terminal end of sacculus to the base of costa. *Anabasis* belongs in a group of genera, including *Acrobasis* Zeller, that share the presence of conspicuously enlarged and angulate male antennae (Heinrich, 1986).

Material of *A. ochrodesma* was not examined; illustrations in Heinrich (1956) and Neunzig (1986) were used for comparative purposes. The type of *A. infusella* was not examined; its identity follows Roesler (1983), who presumably studied the type specimens deposited at The Natural History Museum (London), as

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well as illustrated the adults and genitalia. Types of *A. fusciflavida* and specimens examined of *A. infusella* are deposited in the Institute of Zoology, Chinese Academy of Sciences in Beijing.



Fig.1. Venation of *A. infusella* (Meyrick).

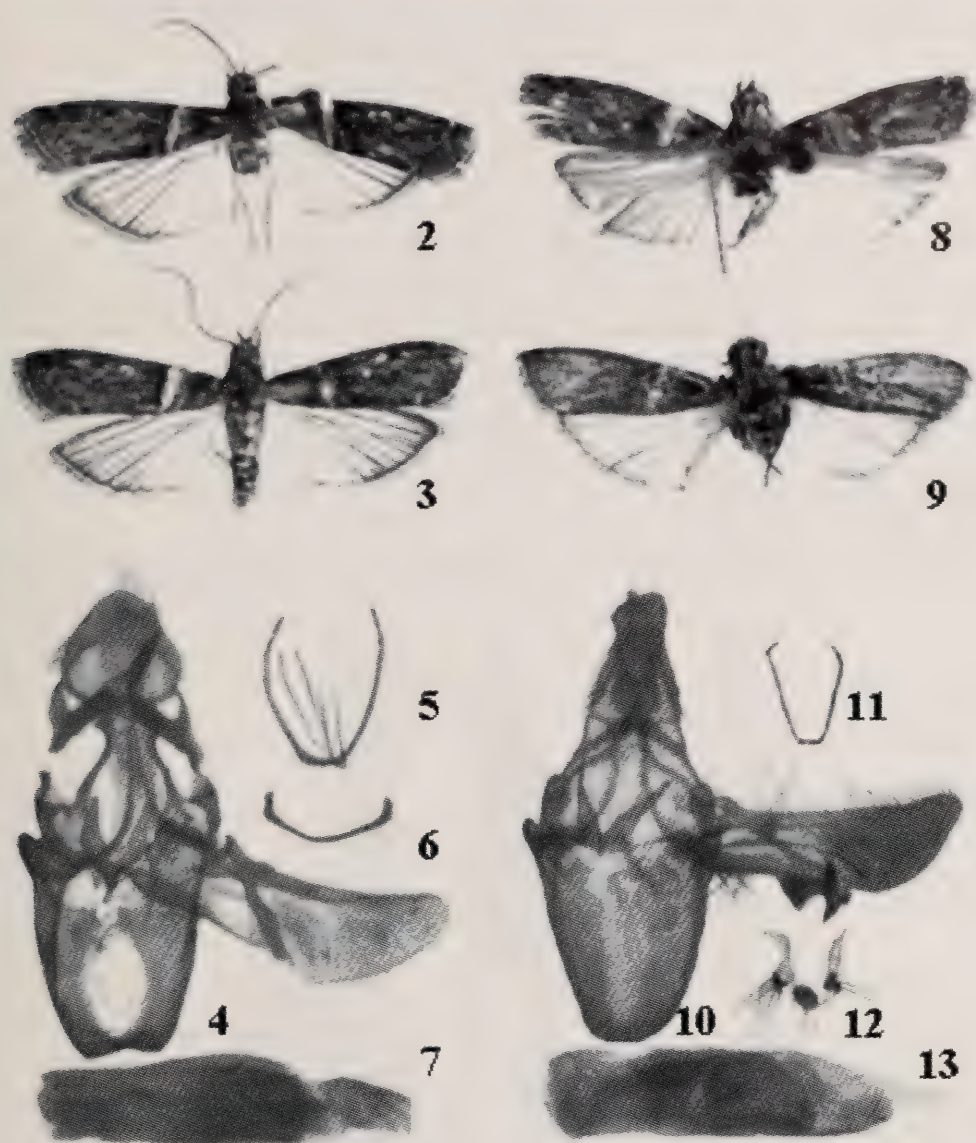
KEY TO THE SPECIES OF *ANABASIS* HEINRICH FROM CHINA

1. Forewing with inside of antemedial line bordered by one line, lateral arms of juxta shorter than gnathos, corpus bursa with two signa
*A. fusciflavida* sp. nov.

Forewing with inside of antemedial line bordered by three narrow lines, lateral arms of juxta longer than gnathos, corpus bursa with one signum
*A. infusella* (Meyrick)

Anabasis fusciflavida Du, Song and Wu, NEW SPECIES (Figs. 2-7, 14)

Diagnosis: This new species is very similar to the Nearctic *Anabasis ochrodesma* (Zeller), from which it can be distinguished by following characters: (1) forewing with underside gray, costa without blackish fuscous dot; (2) female genitalia with ductus bursae shorter than corpus bursae, ductus seminalis inserted at the anterior end of the corpus bursae. In *A. ochrodesma*, the ductus bursae is longer than the corpus bursae, and the ductus seminalis is inserted at the posterior end of corpus bursae.



Figs. 2-7. *Anabasis fusciflava* sp. nov.; Figs. 8-13. *Anabasis infusella* (Meyrick). 2, 8. Male adults; 3, 9. Female adults; 4, 10. Male genitalia without aedeagus; 5, 11. Eighth sternites; 6, 12. Eighth tergites; 7, 13. Aedeagus.

Description (Figs. 2-3): Wingspan 15.5-19.0 mm. Vertex covered with blackish fuscous rough scales. Antennae of male with cilia significantly shorter than width of shaft, cilia of female shorter than male's. Labial palpus extended slightly above vertex, covered with white and black scales; male with the second segment 2 times length of the first, and 1.5 times of the third, whereas female with the second segment 2.5 times length of the first, and 1.2 times of the third. Both color and length of maxillary palpus same as that of the third segment of labial palpus. Forewing three times as long as wide, with ground color mouse gray; antemedial ridge straight, 1/4 away from the basal, consisting of raised black scales outside and yellowish scales inside; postmedial line zigzagged and whitish, both inside and outside bordered with narrow, blackish fuscous line; discal spots black, separate from each other. Hindwing translucent, with cilia white to gray.

Male genitalia (Figs. 4-7). Uncus triangular, almost as long as wide. Gnathos 2/3 length of uncus, with base expanded and apex hooked. Transtilla with posterior margin slightly concave. Valva three times as long as wide, base with a digitiform clasper, which is connected with the transverse, sclerotized ridge; cucullus narrowly rounded; costa straight, sclerotization with basal 2/3rds broad and distal 1/3rd thin, not reaching apex of valva; sacculus with basal half wide and distal half thin, 0.6 times length of valva, underside of sacculus bordered with a line of setae. Juxta V-shaped, well sclerotized, with short setae on lateral arms. Vinculum U-shaped, as long as greatest width, with anterior margin somewhat concave. Aedeagus with one side concave. Eighth tergite and sternite U-shaped.

Female genitalia (Fig. 14). Ovipositor short. Anterior apophyses same length as posterior apophyses. Eighth tergite 2/3 times as long as wide. Ductus bursae membranous, short and thin. Corpus bursae membranous, pear-shaped, three times as long as ductus bursae and with micro-spines in posterior half, signum as a scobinate invaginated cup at anterior half of corpus bursae. Ductus seminalis inserted at anterior end of corpus bursae.

Holotype: male, Sichuan: Fengdu (610 m), 1994. X. 05, Shimei Song. **Paratypes:** 1♂, Hubei: Shennongjia (180 m), 1987. VIII. 04, Yinheng Han; 5♂♂, 17♀♀, same data as holotype; 1♂, 1♀, Sichuan: Emei (800-1000 m), 1957. IV. 27, Fuxing Zhu; 1♀, Sichuan: Wanxian (1200 m), 1994. IX. 27, Shimei Song; 1♀, Yunnan: Xishuangbanna (650 m), 1962. V. 19, Shimei Song; 1♀, Yunnan: Xishuangbanna (1200-1600 m), 1958. VII. 19, Shuyong Wang.

Distribution: China (Hubei, Sichuan, Yunnan).

Etymology: The specific name refers to the yellowish fuscous antemedial scale ridge.



Figs. 14-15. Female genitalia. 14. *Anabasis fusciflava* sp. nov.; 15. *Anabasis infusella* (Meyrick).

***Anabasis infusella* (Meyrick, 1879) NEW COMBINATION**
(Figs. 8-13, 15)

Nephoteryx infusella Meyrick, 1879: 218.

Copamyntis infusella (Meyrick, 1879): Roesler and Küppers, 1981: 40-41.

Diagnosis: A species with short wingspan, with obscure postmedial line and discal spots; valva with one group of setae, sacculus with one group of scales and two groups of setae; corpus bursae gourd-form, with two signa, one U-shaped, composed of toothlike spines and at the posterior end of corpus bursae, the other nipplelike, consisting of scobinations and at the anterior end of corpus bursae.

Redescription (Figs. 8-9): Wingspan 14.0-15.5 mm. Vertex with appressed fuscous scales. In male, labial palpus distinctly above vertex, but in female it hardly reaches vertex; both sexes with labial palpus fuscous, sprinkled with many white scales; the second segment 2 times length of the basal, and 1.5 times length of the terminal. Maxillary palpus short, about as long as the first segment of labial palpus. Forewing grayish fuscous, basal area yellowish fuscous; antemedial scale ridge arched, fuscous, preceded respectively by a narrow whitish line, a black fuscous thin line and a white thin line, followed by a narrow yellow line; postmedial line gray, indistinct, preceded by a black fuscous line and curved inwardly at vein R_2 ; discal spots indistinct. Hindwing yellowish gray, veins and margin yellowish fuscous.

Male genitalia (Figs. 10-13). Uncus as long as wide, apex rounded. Gnathos about half length of uncus, with base broad and tapered apically. Transtilla with posterior margin somewhat concave. Valva with greatest width medially, cucullus narrowly rounded; the transverse, sclerotized ridge connected with the knob-like clasper, terminal end near sacculus with one group of setae; sacculus narrow and long, curved ventrally as two protuberance at basal 1/3 and basal 2/3, and respectively with a group of scales and setae, terminal end curved ventrally as a hook and with a group of setae. Juxta with well sclerotized lateral arms and acute apices. Vinculum U-shaped, longer than greatest width, posterior margin slightly wider than anterior margin. Aedeagus cylindrical. Eighth tergite and sternite U-shaped.

Female genitalia (Fig. 15). Apophyses anterior and apophyses posterior both longer than those in other species of this genus, and the anterior apophyses at most 2/3 times length of the posterior apophyses. Ductus bursae short, only 1/3 times as long as corpus bursae, anterior half with microspines. Corpus bursae cucurbit-shaped, posterior half with microspines, with two signa, one U-shaped, composed of thorn-like spines, and at posterior end near junction with ductus bursae, the other nipple-like, composed of scobinations at anterior end of corpus bursae. Ductus seminalis inserted in middle of corpus bursae.

Material Examined: 8♂♂, 2♀♀, Guangdong: Guangzhou (50 m), 1958. VII.12 ~ IX.19, Lin-yao Wang and Baolin Zhang.

Distribution: China (Guangdong); Bhutan, Sikkim, India, Sri Lanka, Malaysia, Sumatra, Java, Australia (Queensland).

Remarks: *Anabasis* Heinrich seems to be closely related to *Copamyntis* Meyrick based on the enlarged angulate male antennae and the transverse sclerotized ridge on the valva in the male genitalia. *Anabasis* can be distinguished from the latter by the triangular scape of the male antenna, the sclerotized transtilla, and the approximated base of M_2 and M_3 on the forewing. In *Copamyntis*, the scape of the male antenna is expanded and trifurcate apically (Roesler, 1983, Tafel 19: Fig. 49), the transtilla is not sclerotized, and M_2 and M_3 of the forewing are stalked about half. Based on characters of the male antenna and venation, we concluded that *infusella* should not be placed in *Copamyntis*, and we transfer it to *Anabasis*. This species is reported for the first time in China.

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MULTIPLE MATING IN FEMALE *STENOMACRA MARGINELLA* (HETEROPTERA: LARGIDAE) IN CENTRAL MEXICO¹

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ABSTRACT: Understanding the ecological causes and evolutionary consequences of female multiple mating is an important topic of current research. Insects have been used as model systems in this area due to their great variation in number of copulations and mates per female. Experiments with the true bug, *Stenomacra marginella*, indicate that, the day following their first copulation, most females will remate either with their first mate or with a different male, whether he is virgin or had mated the previous day. Field data show that a substantial proportion of females mate multiple times. These results suggest that post-copulatory sexual selection may be important in *S. marginella*; this idea provides testable hypotheses to explain different aspects of the mating behavior of this species.

KEY WORDS: Copulation, polyandry, repeated mating, Heteroptera, central Mexico

Multiple mating is common in female insects, although there is wide intra- and inter-specific variation in the number of copulations and mates per female (Thornhill and Alcock, 1983; Arnqvist and Nilsson, 2000). The benefits of polyandry to females also vary between insect species (Thornhill and Alcock, 1983; Arnqvist and Nilsson, 2000; Jennions and Petrie, 2000), and it is also possible that multiple mating by females is a product of antagonistic male adaptations that result in sub-optimal female mating rates (Holland and Rice, 1998). The degree of polyandry is a key variable for understanding the nature and strength of sexual selection (Eberhard, 1996; Danielsson, 1998), and the evolution of mating systems (Thornhill and Alcock, 1983). For these reasons it is important to assess the natural levels of polyandry, as a first step towards understanding mating systems. In this paper we present the results of experimental and field studies on multiple mating by females of the true bug *Stenomacra marginella* (Herrich-Schaeffer).

METHODS

Stenomacra marginella (Herrich-Schaeffer) occurs at high population densities in several localities in central México, mainly in areas with heavy human impact (Cibrián-Tovar et al., 1995). It is a univoltine species whose fifth instar nymphs molt more or less synchronously into adults, but remain sexually inactive for about a month (Cuatianquiz et al., 2003). In Tlaxcala, central Mexico, the mating season usually begins in May, when a frenzy of sexual activity is observed, and lasts until September (Cuatianquiz et al., 2003). The male mating system is “scramble competition polygyny” (Thornhill and Alcock, 1983) in which males search for females and court them without interacting aggressively with other males (Cuatianquiz et al., 2003); males also court females during copulation (Eberhard, 1994; Cuatianquiz et al., 2003). Females frequently reject males, mainly towards the end of

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the mating season. Females lay multiple batches of 30-40 eggs, beginning several days after mating.

Female Remating Experiment

Virgin females and males were collected as sexually inactive adults previous to the mating season (see previous section) in the population of San Matías Tepetomatitlán, Tlaxcala, and brought to the Centro Tlaxcala de Biología de la Conducta in the city of Tlaxcala. Virgin individuals were kept in unisexual groups (females in a glass cage—55.5 x 25 x 30 cm—and males in two 3 liter plastic bottles) and fed with *Buddleia cordata* (Loganiaceae) fresh leaves and a solution of water with 20 g of sugar, ~0.2 ml of hydrolyzed vegetal protein (eight drops of “Jugo Maggi”™) and 37 ml of raw egg white (amounts needed to produce 100 ml of solution) absorbed in small balls of cotton that we changed every other day. Matings were obtained by placing a female and a male in a glass Petri dish (10 cm diameter x 2 cm height) between 11 and 12 in the morning, when a peak of mating activity occurs in the field.

The remating experiment was performed during the mating seasons of 2002 and 2003, according to the following protocol: (1) Virgin females were mated with virgin males. (2) After mating, females were isolated overnight in plastic Petri dishes (10 cm diameter x 1.5 cm height) with food. (3) The following day, mated females were allocated to the following treatments: (a) Repeated copulations ($n_{2002} = 24$, $n_{2003} = 31$): females were re-exposed to their first mate; (b) Polyandry VM ($n_{2002} = 52$, $n_{2003} = 64$): females were exposed to a new virgin male; and (c) Polyandry MM ($n_{2002} = 25$, $n_{2003} = 30$): females were exposed to a male that had mated for the first time in his life the previous day with a different female. If the female did not remate within one hour, the pair was separated and the female was exposed to the same type of male, once a day for 1 hour (at most two more days).

Female Remating in the Field

This study was done in the population of the Rectoría campus of the UAT, in the city of Tlaxcala, in two isolated trees of *Buddleia cordata* with large numbers of *S. marginella*. A total of 792 females and 796 males were marked individually in 2002, and 396 females and 396 males in 2003, during the pre-reproductive phase; marks were numbers written with nontoxic watercolor paint (Vinci™) on the corium of one or both anterior wings. During the mating season, between one and four daily scanning samplings were made during 45 days in 2002, and between one and two daily scanning samplings during 45 days in 2003; samplings were made during the daytime since there is almost no activity during the night (personal observation). During each scan, the identities of marked females that were copulating on the trunk, branches and leaves that were within the observer's field of vision standing on the ground (i.e., up to about two m) were recorded, along with the identity of the mating male, when he was marked.

RESULTS

Female Remating Experiment

In both replicates of the laboratory experiment (2002 and 2003), most females (92%) remated the day following the first copulation, irrespective of whether it was the same male they copulated with for the first time (Repeated copulations: 23/24 in 2002 and 29/31 in 2003), or a different male, whether he was virgin (Polyandry

VM: 47/52 in 2002 and 58/64 in 2003) or had mated the previous day (Polyandry MM: 24/25 in 2002 and 28/30 in 2003). Two Polyandry VM and one Polyandry MM females remated two days after their first copula and one Polyandry VM female three days after her first copula. Fourteen females (6.2%) did not remate in any of the three days they were exposed to males (Repeated copulations: $n = 3$; Polyandry VM: $n = 9$; Polyandry MM: $n = 2$). No significant differences between-years in the frequency of females remating within each treatment were observed (Two-tailed Fisher's exact probability tests; Repeated copulations: $P = 1$; Polyandry VM: $P = 0.73$; Polyandry MM: $P = 1$), nor between treatments ($G = 0.64$; $P > 0.7$; $df = 2$; data of both years pooled).

Female Remating in the Field

In the field, many marked females were not resighted; an estimate of the proportion of these females is not possible because only marked females that were copulating were recorded. In 2002, 206 marked females (26%) were observed copulating at least once, and 46 (22.3% of the copulating females) were observed mating more than once (between 2 and 5 times; median [25% quartile—75% quartile] = 2 [2—3]). In 2003, 56 marked females (14.1%) were observed copulating at least once, and five (8.9% of the copulating females) were observed mating more than once (between 2 and 5 times; median [25% quartile—75% quartile] = 2 [2—4]). In 2002 there were greater observed frequencies of mated females ($X^2 = 21.63$; $P < 0.0001$; $df = 1$) and of multiply mated females ($X^2 = 5.04$; $P = 0.025$; $df = 1$) than in 2003. These differences were probably due to the fact that the sampling effort was lower in 2003 (see methods). Unfortunately, despite the relatively high number of males marked in both years ($n = 1192$), most multiply mated females were observed copulating with unmarked males (46/51), so we cannot be sure if they mated with different males. Only five females were observed mating with one marked male and one or more unmarked males; one of these females was observed copulating three times with the same marked male in different days and once with an unmarked male. In 2002, 84 marked males (10.6%) mated once and 34 more than once (23 mated twice; maximum = 5); in 2003, 21 marked males (5.3%) mated once and two mated thrice. Only four multiply mated males copulated with marked females.

DISCUSSION

According to commonly used standards (Thornhill and Alcock, 1983), females of *S. marginella* are polyandrous and, at least sometimes, copulate repeatedly with the same male. However, our estimates have several possible sources of bias. In the experiment it is possible that confinement of the pair in a small space (10 cm diameter x 2 cm height; adult body length varies between 12 and 15 mm) resulted in abnormally high remating rates if females were not able to exhibit the behaviors used in the field to avoid unwanted copulations (e.g., run away from males). Although we cannot discard this possibility, males do not seem to be able to force females to mate because intromission requires that females open their valvae and males are not able to force them to open (Moreno, 2005). Furthermore, females can reject males by rising their abdomen making it impossible for males to reach the tip (because of their smaller size), and males usually stop harassing females after several minutes of failed attempts of mating. In the field study, logistic constraints resulted in a suboptimal sampling effort that may have led to underestimation of

remating rates because copulations could have been missed between observations (in the laboratory copula duration varies widely; in a sample of 12 couples of virgin males and females copulation lasted a median [minimum—maximum] of 95 [7—343] min). Furthermore, the higher parts of the trees were not sampled and many marked females were observed moving up the trees. Another problem was that, although almost twelve hundred males were marked, most copulations observed involved unmarked males, probably because of the relatively high mobility of the males and the extremely high population density.

Independent of the exact level of polyandry in *S. marginella*, our results suggest that in the population studied there is potential for post-copulatory sexual selection. In particular, sperm competition could be intense because the period of time between copulation and egg laying is long (for example, in a sample of 21 twice mated females the median [25% quartile—75% quartile] number of days between second copulation and laying a first batch of eggs was 15 [10—20]) and, therefore, increases the probability of mating with multiple males previous to egg laying. Polyandry can also result in opportunity for cryptic female choice in *S. marginella* and the existence of copulatory courtship (Eberhard, 1994; Cuatianquiz et al., 2003) is consistent with this expectation (Eberhard 1994, 1996).

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MONOLEPTA ANATOLICA BEZDEK, 1998 (COLEOPTERA: CHRYSOMELIDAE): A NEW PEST ON SOME STONE FRUIT TREES (ROSACEAE) IN TURKEY¹

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ABSTRACT: *Monolepta anatolica* Bezdek, 1998, a little known galerucine hitherto known only from Turkey, is reported as a new pest of some stone fruit trees (Rosaceae) such as peach [*Prunus persica* (L.)], almond (*Amygdalus communis* L.), plum (*Prunus divaricata* Ledeb.), and pear (*Pyrus eleagrifolia* Pall.) in Turkey. Surveys conducted during June-August 2005 in two selected stations in Isparta (southern Turkey), showed large *M. anatolica* adult population densities (over 5,000 beetles per tree), particularly on leaves of almond trees. By the end of August 2005, the level of injured almond leaves reached almost 99%, and 74% in peach leaves.

KEY WORDS: Galerucinae, *Monolepta anatolica*, pests, stone fruit trees, Turkey

Monolepta Chevrolat, 1837 is the largest genus of the Galerucinae comprising about 600 species worldwide (Wagner, 2004). The genus is poorly represented in Palearctic region as most of the species are distributed in tropical regions (Lopatin, 1984). *Monolepta* differs from the other galerucine genera by its basally blackened first tarsomere of the hind tarsi. The first tarsomere of the hind legs is about three times longer than the second and third altogether (Warchalowski, 2003).

Monolepta anatolica Bezdek was described from the southwest coast of Turkey in 1998 and it is the third Mediterranean species of this genus. This species is easily recognized by its soft and entirely pale flavous body. The specimens we collected are about 3.2-4.3 mm long, in almost perfect agreement with what Bezdek (1998) reported (3.3-4.2 mm). All other morphological characters and genitalia figures were as in Bezdek (1998). The other two described Mediterranean species of *Monolepta* are: *M. lepida* Reiche from Israel and *M. heydeni* Joannis from Egypt (Warchalowski, 2003). While Bezdek (1998) described the species, no available data about the ecology and host plants of *M. anatolica* were available until the present paper.

During the 2004 survey of chrysomelids from the Isparta region (Turkey), we came upon a large population of *M. anatolica* adults. As far as we are aware, *M. anatolica* had not been collected since 1998. Adults were flying around peach [*Prunus persica* (L.)] and almond (*Amygdalus communis* L.) trees in such quantities that we were reminded of the solitary wave phenomenon (Kovalev, 2004).

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Monolepta anatolica adults were first found in July 2004, feeding densely on the leaves of peach and almond trees (Fig. 1). Thereafter (mid August 2004), beetles were also observed on plum (*Prunus divaricata* Ledeb.) and pear (*Pyrus eleagrifolia* Pall.) trees in different field surveys. After recognizing that *M. anatolica* is a new pest of some stone fruit trees, in 2005 we conducted regular observations in two selected stations, one including almond, the other peach trees, to determine the population density of *M. anatolica* and its degree of damage to stone fruit trees. This paper extends the geographical distribution of this species to the west along the Mediterranean coast of Turkey and provides extensive ecological data about *M. anatolica*.



Fig. 1. Feeding adults of *M. anatolica* and its damage typical on *Prunus persica* (L.)

METHODS

Weekly samplings of seriously attacked by *M. anatolica* affected stone fruit trees were carried out from mid June to the end of August 2005 at two stations located in Isparta province of Turkey. The first station is a natural arid area of about 0.1 ha, mainly dominated by almond trees (elevation 1126 m, 37° 50' 39" N, 30° 28' 02" E). The second station is a peach orchard of about 0.05 ha located near a stream bank (elevation 859 m, 37° 39' 38" N, 30° 39' 15" E). The stations are 40 km apart from each other and both of them received no pesticide applications during the study period.

Yellow sticky traps (0.1 cm thick, 20 x 20 cm) were used for monitoring *M. anatolica* populations (Fig. 2). Five trees, each about 2.5-3.0 m high, were selected randomly in each station. Three traps were hung on each of the five selected trees: the first located 1.0-1.25 m above ground, and the other two placed about 0.5 m above the first, in opposite sites of the tree. The trees were observed weekly and the traps were replaced with the fresh ones. Sampling was performed at the same dates for both stations. In the laboratory, beetles were counted manually with the help of a forceps. The number of beetles for each tree and the total number of beetles for the sampling date were recorded.



Fig. 2. Yellow sticky trap used for sampling *M. anatolica*.

In order to determine the percent damage, that is the number of leaves showing feeding marks caused by *M. anatolica* adults (Fig. 1), 100 leaves were randomly collected from each tree at each sampling site. In total, 10,000 leaves were collected from both stations. The injured leaves were counted and used to estimate the ratio of damage for every sampling. Except for *M. anatolica* adults, no other herbivorous insects (including *M. anatolica* larvae) were observed on the sampled trees, during whole study.

Voucher specimens have been deposited in the Department of Biology, Faculty of Arts and Sciences, Süleyman Demirel University, Isparta, Turkey.

RESULTS AND DISCUSSION

The first *M. anatolica* adults appear in early June. At first, adults especially prefer feeding on fresh leaves located in upper parts of the trees but in early July beetles disperse to other parts of the tree. The highest population density of

M. anatolica adults was recorded in mid July 2005 for peach, and in late July 2005 for almond. The adult population size and percentage of injured leaves in peach and almond trees during the sampled dates are shown in Figures 3 and 4. While the adult populations of *M. anatolica* experience a rapid rise and decline, the percentage of injured leaves grows asymptotically and stabilizes as the density of *M. anatolica* adults declines.

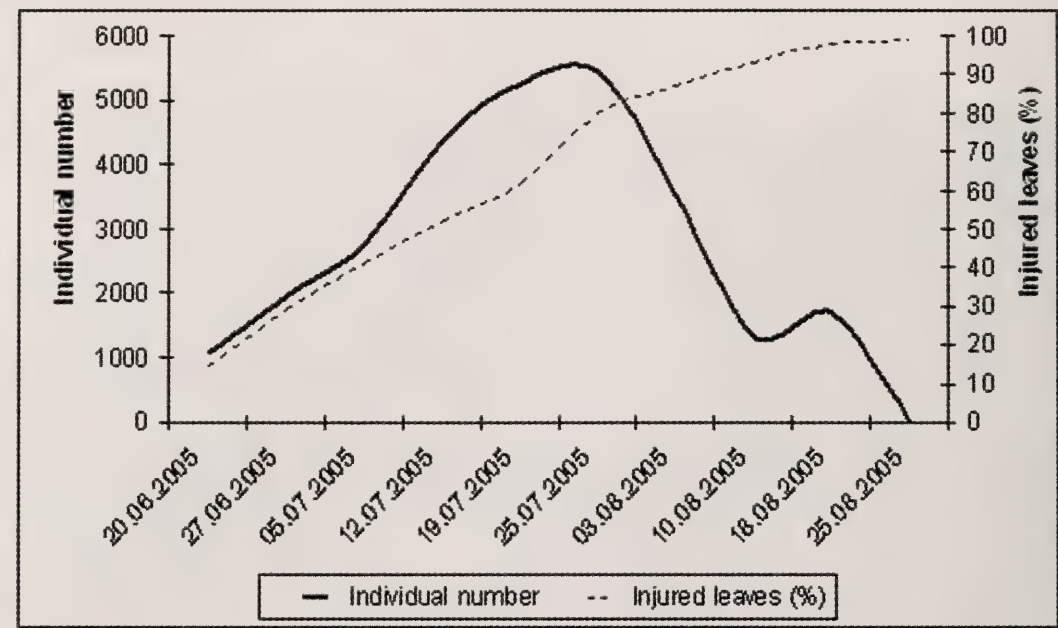


Fig. 3. Population and injury levels of *M. anatolica* on almond trees from mid June to the end of August 2005.

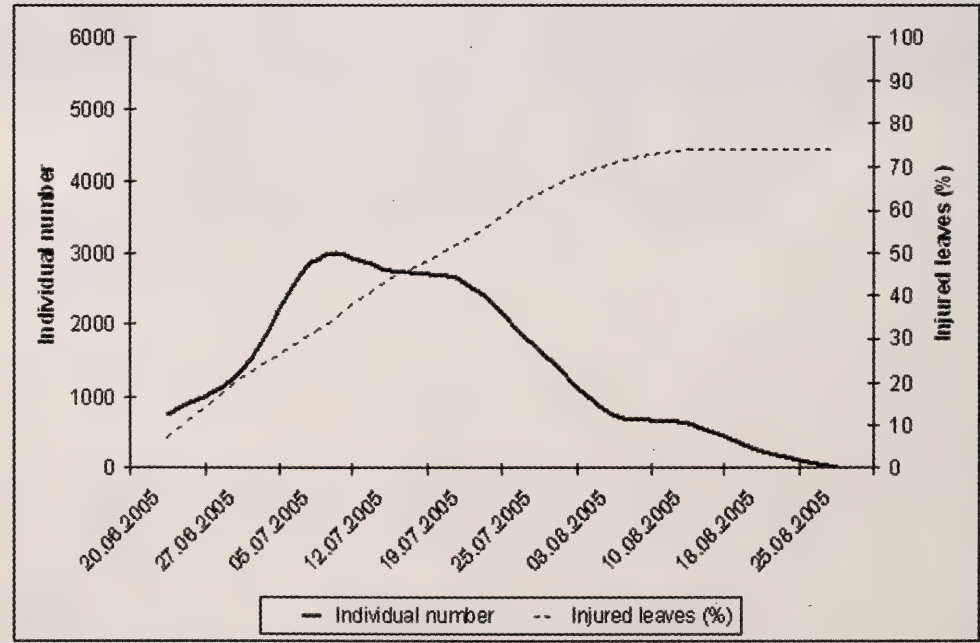


Fig. 4. Population and injury levels of *M. anatolica* on peach trees from mid June to the end of August 2005.

A total of 40,978 beetles were collected in this study: 27,341 on almond and 13,637 on peach. We do not know whether there are within-tree spatial differences in the population densities of *M. anatolica*. The average number of beetles per tree was higher in almond (5468.2, sd = 1703.5, n = 5) than in peach (2727.4, sd = 990.4, n = 5, p-value: approx. 0.01, t-test, <http://www.changbioscience.com/stat/ttest.html>). We need to perform host plant feeding experiments on unexcised leaves (Santiago-Blay and Blay-Sálmóns, 2004) to determine the true extent of the host-feeding of *M. anatolica*. The differences in population density of *M. anatolica* adults may reflect environmental, genetic, and/or random effects.

Monolepta anatolica can cause extreme damage to host plants by feeding upon nearly all leaves. For instance, the injury level may be as high as 99% of the leaves on almond trees. Beetles cause highly visible damage such that in the end of August they are almost without any leaves (Fig. 5). This level reaches about 74% of the leaves on peach trees (Fig. 6).

Evidently, *M. anatolica* has the potential of becoming an important pest of some stone fruit trees, including almond, peach, pear, plum, and other rosacean stone fruit trees in Turkey and in locations with Mediterranean climates worldwide (http://en.wikipedia.org/wiki/Mediterranean_climate), including the agriculturally important California (U.S.A.). Further studies must be performed on the biology of *M. anatolica*.



Fig. 5. Overall view of an almond tree damaged by *M. anatolica* by the end of August 2005.

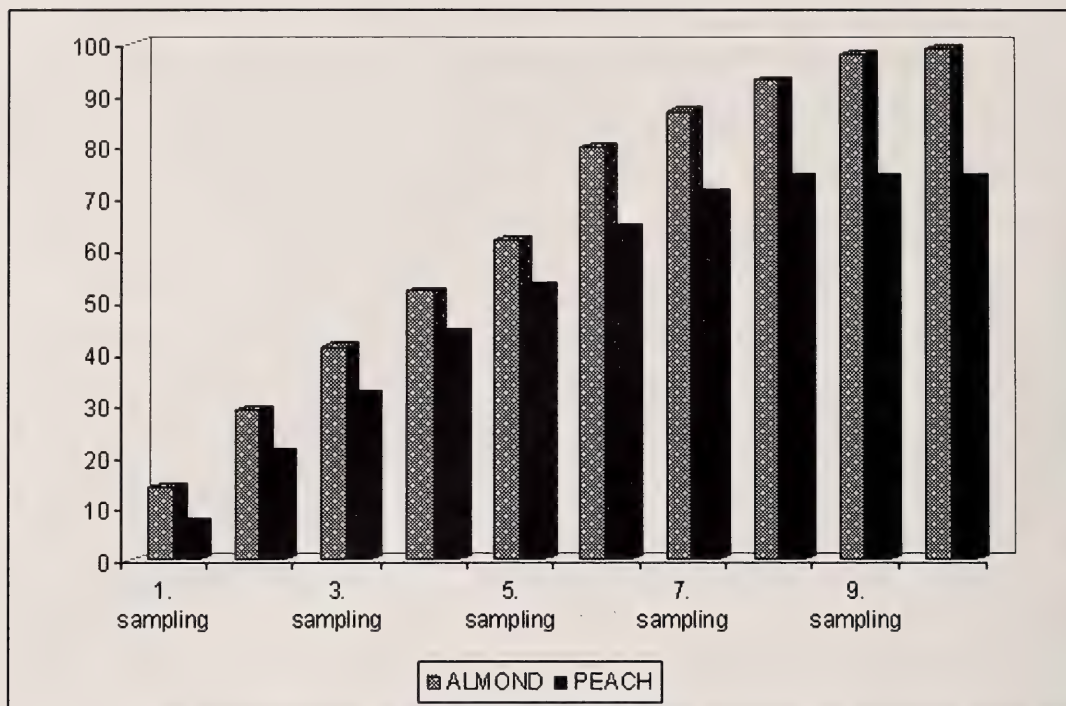


Fig. 6. Percentage of damage for almond and peach trees caused by *M. anatolica*.

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POSSIBLE IMPLICATIONS OF TWO NEW ANGIOSPERM FLOWERS FROM BURMESE AMBER (LOWER CRETACEOUS) FOR WELL-ESTABLISHED AND DIVERSIFIED INSECT-PLANT ASSOCIATIONS¹

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ABSTRACT: Two undescribed flowers in Burmese amber, and additional evidence herein discussed, support the inference that substantially diverse forests, possibly with well-established and diversified insect-plant associations, were already established and preserved by 100 Ma.

KEY WORDS: Lower Cretaceous, fossil, Burmese amber, insect-plant associations, angiosperms, Pseudopolycentropodidae

Cretaceous insect and/or plant fossils are important because they can be used to test various hypotheses regarding the timing of insect-plant associations (Labandeira 2005a, b). Morphological features, detailed elsewhere (Santiago-Blay et al., in preparation), of two different flowers entombed in Burmese amber (circa 115-100 Ma, see references in Santiago-Blay et al. 2004), suggest that insect-plant interactions were well-established and diversified at least 115-100 Ma in southeastern Laurasia. Briefly, those features include the presence of a shallow bowl (sb) at the base of the gynoecium in one flower (Fig. 1) as well as conspicuously abundant pilosity (p), a tubular gynoecium (g), and possible food sources (fs) on the other (Fig. 2). While these flowers do not constitute by themselves definitive proof of entomophily, they are suggestive of well-established and diversified insect-plant interactions as such specialized morphological features are often associated with entomophilous flowers (e.g. Barth 1985, Endress 1994, Faegri and van der Pijl 1971, Meeuse and Morris 1984, Proctor et al., 1996).

As far as we are aware, only four angiosperms have been (or are being formally) described from Burmese amber (Poinar 2004, Poinar et al., accepted, Santiago-Blay et al., in preparation) based on flowers. Other fossilized botanical inclusions are known for Burmese amber, including "hepatophyte thalli, an archegoniophore of Marchantiaceae, and leafy shoots of *Metasequoia*" (Grimaldi et al., 2002) and additional materials in the collections of authors SRA and RTB (Santiago-Blay et al., in preparation). Specimens lacking reproductive structures can be difficult to identify due to the absence of diagnostic and/or synapomorphic characters as well as their incomplete nature.

Beetles, flies, moths, wasps, and other insects [Antropov (2000), Grimaldi and Engel (2005), Rasnitsyn and Ross (2000), Ross and York (2000), and others] have

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already been documented in Burmese amber, although it is difficult to determine which ones were actual pollinators. In the case of the two flowers illustrated (Figs. 1-2), insects could have used them as feeding stations. The flower with a shallow bowl at the base of the gynoecium (Fig. 1) could have been nectarated or pollinated by an anthophilous brachyceran fly (Labandeira 2005c) or by a generalist winged insect. Though not yet proven as a definitive pollinator, members of the Pseudopolycentropodidae (Diptera, Fig. 3) often exhibit an unusually long, slender, and rigid proboscis, suggesting an already established association with plants (thought not necessarily the angiosperms herein illustrated) for imbibition of gymnospermous pollination drops (Labandeira et al., submitted) or nectar probing from flowers (Anderson and Poinar, independent pers. comm. to Santiago-Blay, January 2005). Furthermore, Labandeira (1998, 2000, 2002) has shown that pollination syndromes have a geological record extending as far back as the mid-Mesozoic, well before the sudden diversification of angiosperms (Labandeira et al., submitted).

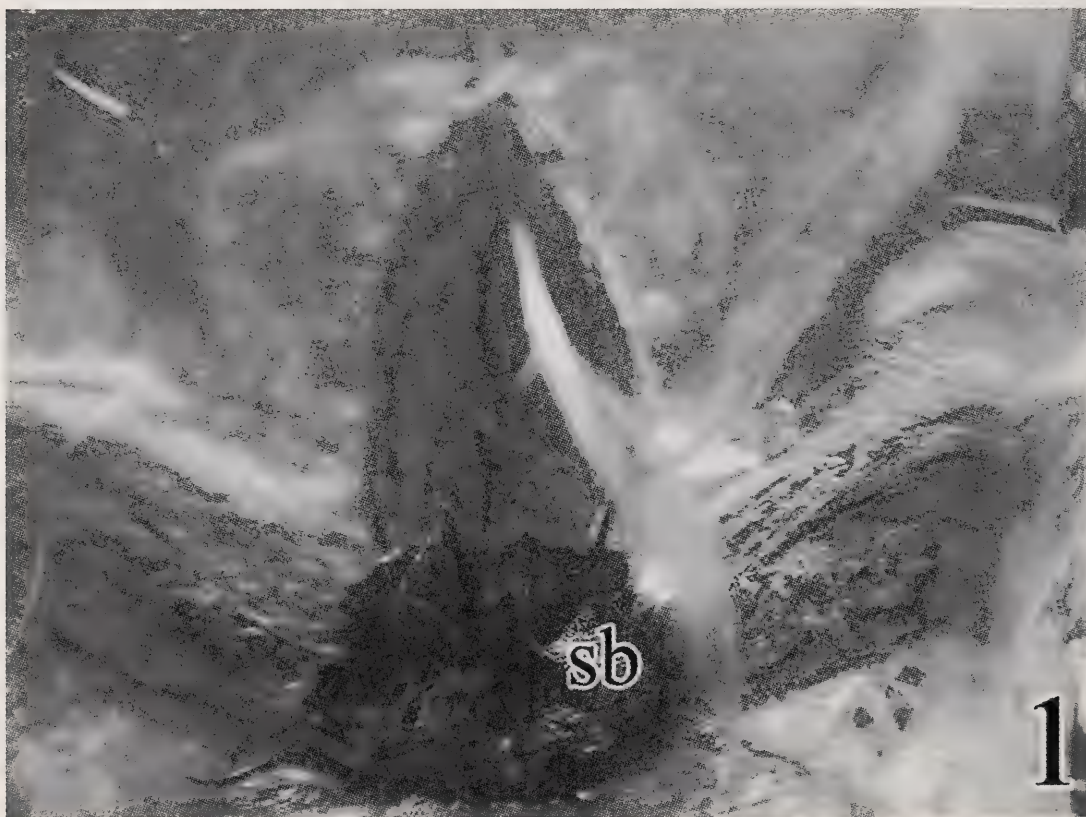
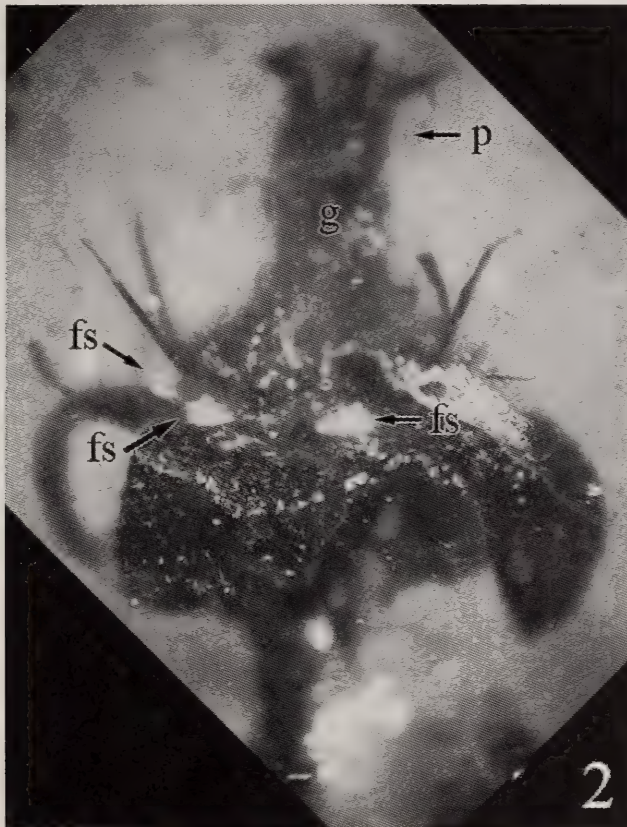


Fig. 1. Flower in Burmese amber showing its possible entomophilous traits. The shallow bowl (sb) at base of the gynoecium may have been a site for insect feeding. Photo taken by author Ronald T. Buckley.

There is a huge body of literature on insect-plant interactions and their presumed connection with the rise of angiosperms. While such interactions probably are partially associated with the geologically sudden diversification of angiosperms, other cases suggest that some insect-plant interactions predate and/or are unrelated to the rise of angiosperms (Gorelick 2001; Labandeira 1998; Labandeira et al., submitted; Lloyd 1992).

As for the botanical source of amber from Burma, Grimaldi et al. (2002) indicated that “*Metasequoia* is possibly the source of the amber” [modern classifications tend to place *Metasequoia* in the Cupressaceae (Judd et al., 2002)]. Studies with solid state nuclear magnetic resonance spectroscopy using the carbon 13 nucleus suggest that burmite and other fossil resins belong to a large, worldwide assemblage (fossil resin Group B, Lambert and Poinar 2002). Some of the Group B resins perhaps belong in the Dipterocarpaceae (modern resins, Group D, Lambert et al., 2002), although this has not been firmly established. Modern geographic sources for Group B fossil resins include Borneo, Sumatra, Australia, Papua New Guinea, India, and North America. Nevertheless, Group B fossil resins are spectroscopically distinct from the partially sympatric *Agathis*-related plants (fossil resins, Group A of Lambert et al., 2002; modern resins, group CA, Cupressaceae and Araucariaceae of Lambert et al., 2005).



Figs. 2. A second flower in Burmese amber showing their possible entomophilous traits. Note tubular gynoecium (g), abundant pilosity (p), and possible food sources (fs). Both flowers illustrated in this paper are deposited in the private collection of Ron T. Buckley.

A handful of flowers has been described from younger amberiferous formations, such as those from the Dominican Republic and/or the Baltic region, including the families Araceae (Bogner 1976), Arecaceae (Poinar 2002), Fagaceae (Mai 2003), and Leguminosae (Poinar and Brown 2002). Interestingly, no flowers have yet been described from Lebanese amber (Poinar and Milki 2001), which is Aptian (Grimaldi et al., 1993) to Hauterivian (Roth et al., 1996) in age, approximately 120-135 Ma, although most localities appear to be closer to 120 Ma (Labandeira to Santiago-Blay,

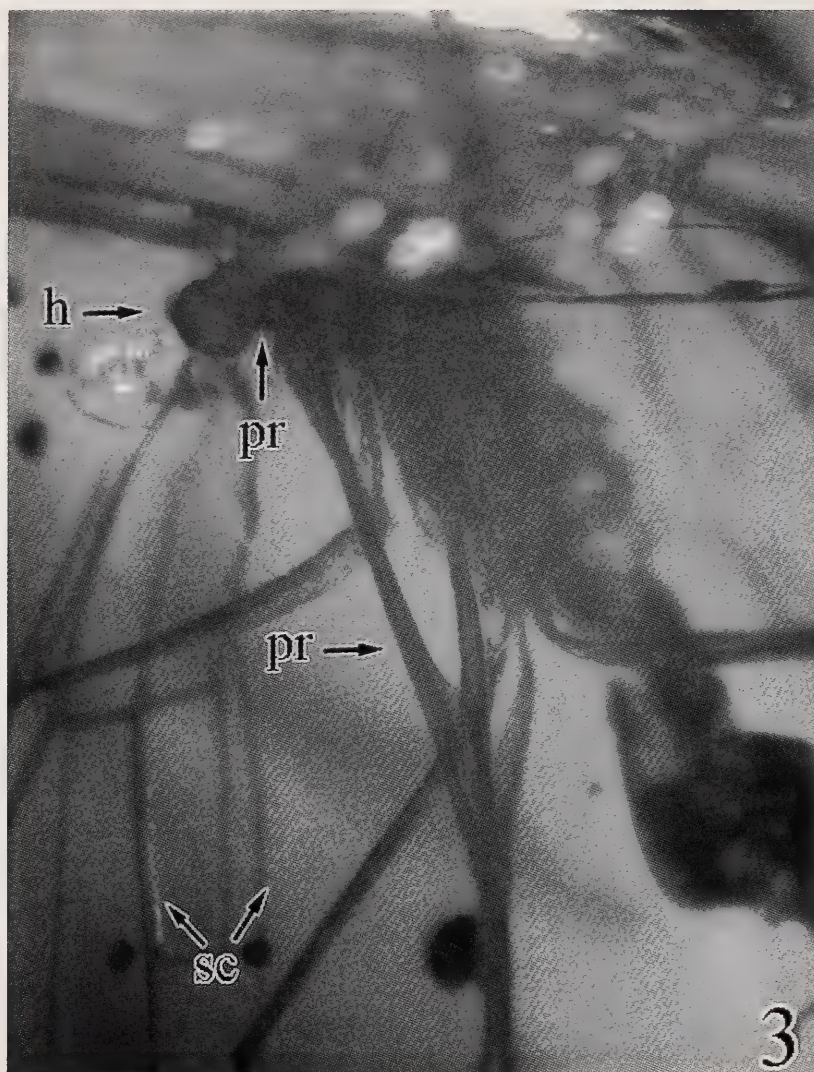


Fig. 3. Pseudopolycentropodid showing elongated, slender, rigid proboscis, (pr) perhaps used to probe nectar/pollen in flowers (Anderson and Poinar, pers. comm. to Santiago-Blay); h, indicates head, and sc, wing scales. The pseudopolycentropodid is deposited in the private collection of Scott R. Anderson. Photos taken by author Scott R. Anderson.

pers. comm., December 2005). Flowering plants preserved in various non-amber matrices have been extensively documented in the Cretaceous throughout the World and they exhibit remarkable diversity (e.g. Archaeofractaceae, Sun et al., 2002; Magnoliidae, Dilcher and Crane 1984, Crane and Dilcher 1984; Lauraceae, Drinnian et al., 1990; and other lineages, Friis 1984).

The known diversity of Burmese amber insect and plant inclusions, the inferred morphological specialization of flowering plants, possibly related to entomophily, and NMR evidence support the inference that substantially diverse forests, possibly with well-established and diversified insect-plant associations, were already established and preserved by 115-100 Ma. The few angiosperms and potential pollinators discovered thus far in Burmese amber are assisting in refining our understanding of the possible connection between insect-plant interactions and the rise of angiosperms.

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LABORATORY PREDATION AND SCAVENGING OF THREE GROUND BEETLE (CARABIDAE) SPECIES FROM THE U.S.A. ON FALL ARMYWORM, *SPODOPTERA* *FRUGIPERDA* (LEPIDOPTERA: NOCTUIDAE) LARVAE¹

Orrey P. Young²

ABSTRACT: *Chlaenius tomentosus*, *Cicindela punctulata*, and *Scarites subterraneus* (Coleoptera: Carabidae) were evaluated in the laboratory for their ability to survive on a diet of either live or dead lepidopteran larvae (*Spodoptera frugiperda*) as compared to the absence of food. All three species survived at least twice as long on prey, alive or dead, than on a regime without food. The significance of this finding is discussed.

KEY WORDS: *Chlaenius tomentosus*, *Cicindela punctulata*, *Scarites subterraneus*, Carabidae, *Spodoptera frugiperda*, Lepidoptera, predation, scavenging, agronomic

Numerous studies have documented the role of ground beetles (Coleoptera: Carabidae) as predators of arthropods in a variety of habitats and ecosystems (e.g. Desender et al., 1994). The ability of carabids to also function as scavengers of dead arthropods is not well documented, as has been frequently noted (e.g. Lovei and Sunderland 1996). This dearth of information is most evident in agricultural situations, though scavenging may be a frequent and important phenomenon. The utilization of dead insects in row crop situations in one instance has been examined, but carabids were unfortunately not common in the particular area studied (Young 1984a). The purpose of this experiment is to examine the capability of three common and widely distributed carabid species to utilize and survive on a diet of larvae (live or dead) of several lepidopteran crop pests.

METHODS

Individuals of each of three species of Carabidae (Coleoptera) were evaluated in the laboratory for their ability to maintain themselves on an exclusive diet of either dead or live lepidopteran larvae, as compared to a regime of no food. Those carabid species were (1) *Chlaenius tomentosus* (Say), (2) *Cicindela punctulata* Olivier, and (3) *Scarites subterraneus* (Fab.).

Beetles were captured during the period 24 Mar to 16 June 1982 in a walk-in UV-light trap 6 km NW of Tifton, Tift Co., Georgia. This trap was surrounded by fields planted in peanuts, corn, and soybeans. Individuals were brought into the laboratory and placed in separate 17 x 12 x 6 cm clear plastic containers with tight-fitting lids. A sheet of paper toweling was cut to fit the bottom of the container and moistened with water. Additional paper was crinkled and added to provide refuge sites. Previous experiments had demonstrated no differences in longevity of a carabid predator of lepidopteran larvae in laboratory containers with or without soil (Young 1985a).

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Early in the season – 25-27 March 1982 – the first of the three carabid species to become abundant – *Chlaenius tomentosus* – was tested for its ability to attack and consume four species of lepidopteran larvae – fall armyworm (FAW), *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae); corn earworm (CEW), *Helicoverpa zea* (Boddie) (Lepidoptera: Noctuidae); European corn borer (ECB), *Ostrinia nubilalis* (Hubner) (Lepidoptera: Pyralidae); tobacco hornworm (THW), *Manduca sexta* (L.) (Lepidoptera: Sphingidae). Based on the results of this preliminary experiment (Table 1), FAW larvae were chosen for exposure to all three carabid species.

Table 1. Exposure of *Chlaenius tomentosus** to four species of lepidopteran larvae**

Protocol	FAW	CEW	ECB	THW
# offered	10	10	10	10
# attacked	10	10	8	5
# consumed	10	8	4	0
% consumed	100	80	40	0

*Each of ten beetles, in separate containers, offered one larva (20-25 mm) of each type; terminated after 24 hours.

* *FAW – fall armyworm

CEW – corn earworm

ECB – European corn borer

THW – tobacco hornworm

After beetles of the three species had been brought into the laboratory and spent 24 hrs in the aforementioned individual containers, each beetle was offered either (1) two coddled (killed by placement in 90° C water for 5 minutes) 4-5th instar larvae (ca. 30 mm) of the FAW; (2) two alive FAW larvae (ca. 30 mm); or (3) no food. Containers were maintained at ambient room conditions (ca. 25°C, 75% RH) and placed so as to be exposed to outside photoperiod, examined every 3 or 4 days, cleaned of debris, fresh moistened paper added, and the feeding regime continued. Preparatory studies had indicated that more than two larvae offered every 3-4 days resulted in some larvae unutilized. Experimental procedure for each beetle ended upon death.

For each beetle species, 7 to 10 individuals were evaluated in each of the three feeding regimes, with the date of individual death calculated to be halfway between the last day observed alive and the first day observed dead (rounded up). The composite value for each species in each feeding regime is the mean of the individual survival durations. Statistical analysis was performed with WINKS Kwikstat for Windows software, 5th edition.

RESULTS AND DISCUSSION

Data, presented in Table 2, indicates that all three adult beetle species were able to survive at least twice as long on a diet of either live or dead lepidopteran larvae when compared with a no-food regime. Grouping all three carabid species together ($n = 79$), the mean survival period for those without food ($n = 26$) was 34.9 days, for those offered live FAW ($n = 25$) – 87.7 days, and those offered dead FAW ($n = 28$) – 83.3 days. Using the ANOVA Newman-Keuls Multiple Comparison test, there were significant differences ($n = 79$; $p < 0.05$) between the no food regimes and either the live or dead FAW feeding regimes. There were no significant differences in survival rates between live and dead FAW feeding regimes ($n = 53$, Student's t -test, $P = 0.64$), though survival was consistently longer in groups offered live larvae. *Chlaenius tomentosus* survived the longest on larval food, the last individual dying 131 days after initiation, compared with 63 days for the longest surviving individual without food. *Cicindela punctulata* survived for the shortest period of any of the three species, with 15 days the shortest period without food and 42 and 45 days the shortest periods when offered alive or dead larvae respectively. From all appearances and based on published general descriptions of carabid life-histories (e.g. Lovei and Sunderland 1996), it was assumed that all the beetles were adults-of-the-year, initially in the early stages of adult vigor (not senescent), and representative of the species.

The survival values for several of the tested species compare favorably with another carabid previously tested in the same manner. *Calosoma sayi* DeJean survived on average 112 days on a diet of coddled fall armyworm larvae (Young 1985a), and survived on average 58 days without food (Young and Hamm 1985). Although *Calosoma sayi* is a member of a genus known as “caterpillar hunters,” *C. sayi* has been demonstrated to consume a wide variety of non-lepidopteran prey (Young 1984b) and may be similar in food habits to the carabids tested in this experiment. A non-carabid species similarly tested, *Necrodes surinamensis* (F.) (Coleoptera: Silphidae), though a predator and scavenger on larval insects, as well as a consumer of vertebrate carrion, survived for a much shorter period - 4 days without food, 20 days when offered coddled fall armyworm larvae (Young 1985b).

Each of the three species tested are common and widely distributed in the southeastern United States (Loding 1945, Fattig 1949, Kirk 1970), and belong to genera that are well known as predators of arthropods (Balduf 1935). *Chlaenius tomentosus* – This genus belongs to a carabid subfamily containing mostly food generalists (Hengeveld 1980), and some members of the genus are common in agricultural situations (Kirk 1970). This species is recorded as consuming various insects (stage not noted), earthworms, fungi, and vegetal tissue (Larochelle 1974a). *Cicindela punctulata* - Adults of the genus prey on a wide variety of living arthropods (Balduf 1935), with scattered anecdotal records of their feeding on dead arthropods and even on dead vertebrates (Pearson and Vogler 2001). This species is univoltine with larvae overwintering and adults appearing in June (Knisley and Schultz 1997). Adults of this species are recorded as consuming numerous living adult carabid species, as well as ants, grasshoppers, and lepidopteran larvae (Larochelle 1974b). *Scarites subterraneus* – Adults of the genus are strictly predaceous (Dillon and Dillon 1961). This species is recorded consuming larvae of elaterid, scarabaeid, and coccinellid beetles (Balduf 1935).

Table 2. Survival duration for three carabid species in a feeding experiment

	<i>Chlaenius tomentosus</i>	<i>Cicindela punctulata</i>	<i>Scarites subterraneus</i>
Size	~15 mm	~14 mm	~17 mm
Period Captured	24 Mar-1 Apr	24-27 May	9-15 Jun
Start of Feeding	2 Apr	28 May	16 Jun
Last death	11 Aug	30 Jul	15 Oct
Survival (days): No food	n = 7, R = 39-63, $\bar{x}$ = 50.1	n = 9, R = 15-21, $\bar{x}$ = 17	n = 10, R = 24-39, $\bar{x}$ = 33.9
Survival days): Live FAW larvae	n = 9, R = 82-131, $\bar{x}$ = 113.4	n = 7, R = 45-63, $\bar{x}$ = 56.1	n = 9, R = 88-121, $\bar{x}$ = 105.7
Survival (days): Dead FAW larvae	n = 10, R = 73-131, $\bar{x}$ = 100	n = 8, R = 42-60, $\bar{x}$ = 52.7	n = 10, R = 76-115, $\bar{x}$ = 104

n = Number of individuals tested
R = Range of survival values
 $\bar{x}$ = Mean of survival values

An interesting relationship is illustrated in this experiment. Given that all three species are of approximately the same physical dimensions, occupy the same habitat, and consume approximately the same foods, it could be expected that they would demonstrate the same ability to withstand starvation. The *Cicindela* species, however, had a survival rate at least one half or less than the other two species. The high energetic demands of the adult *Cicindela* hunting strategy – actively chasing potential prey, and the escape strategy – rapid and sometimes sustained or frequent flight, as compared to the more energetically conservative strategies of the other two species, may explain the need for the *Cicindela* species to consume food more frequently and have less energy storage capacity. In captivity, the *Cicindela* species was considerably more active than the other carabid species in this experiment (unpubl. pers. obs.), also suggesting greater nutritional demands over a shorter period. An additional explanation, though not mutually exclusive, for species differences in ability to withstand starvation involves the predictable availability of food. A species with a broad feeding niche and searching for readily available food has no particular requirement for significant energy storage capabilities. Conversely, a species searching for a narrow range of food items that are relatively rare in time and/or space must have the capability of surviving much longer periods without food. This could be accomplished by physiological mechanisms leading to increased energy storage and/or decreased energy utilization.

This laboratory experiment suggests that all three of the tested carabid species are opportunistic predators and scavengers, capable of detecting and consuming live and moving lepidopteran larvae as well as dead and stationary larvae, and sur-

viving for considerable periods on a diet of both food types. Their ability to capture and consume live larvae of a major southern crop pest, the fall armyworm, though in a laboratory setting, is previously unreported. The scavenger activity of these three species also has not previously been examined, suggesting that their overall role in the ground arthropod fauna of row crops has not been sufficiently appreciated. The fact that many carabid species can be maintained in the laboratory on dried dog food (e.g. Best and Beegle 1977) says little about their capabilities as scavengers of dead insects but does emphasize their broad food preferences. The catholic food choices of these species, especially their scavenging activities, may expose them to potentially lethal food items. In crop situations, the dead larvae of lepidopterans that ground carabids are likely to encounter will probably be victims of either chemical pesticides or pathogenic biocontrol agents, and as such may also be lethal to whatever consumes those (Young 1984a). Unfortunately, although scavengers have been shown to be important components of the nutrient cycling process in some habitats (e.g. Edwards et al., 1970), such demonstration is still lacking for agronomic systems; thus the impact of high mortality on scavengers in agronomic systems caused either by indirect or direct contact with lethal agents, remains to be determined.

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PRODUCTION AND LIFE CYCLE OF *CHIRONOMUS MAJOR* (DIPTERA: CHIRONOMIDAE) IN KENTUCKY LAKE, SOUTHWESTERN KENTUCKY AND NORTHWESTERN TENNESSEE, U.S.A.¹

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ABSTRACT: *Chironomus major* is a large chironomid (larval length up to 50 mm) that occurs sporadically in lakes and ponds throughout the eastern United States. *Chironomus major* is the dominant chironomid in Kentucky Lake, KY, U.S.A. in western shoreline depositional zones 6-10 m deep with mean densities of about 87/m² per month. In the laboratory, eggs hatched in 3-4 days. The life cycle appears to be univoltine. Adult emergence begins in early October (water temp 22°C) and peaks about the first week in November. Mean larval dry weights were 0.002, 0.76, 2.98, and 6.20 mg for first, second, third, and fourth instars. Mean head capsule widths were 0.13, 0.55, 0.78, and 1.03 mm for first, second, third, and fourth instars. Production was estimated as 1.5 g dry mass/m² based on the present study. Although the densities of *C. major* larvae were low, the relatively high standing stock biomass (0.4 g dry mass/m²) contributed much of the production.

KEY WORDS: production, life cycle, *Chironomus major*, Diptera, Chironomidae, Kentucky Lake, Kentucky, U.S.A.

Despite the abundance, diversity, and importance of chironomids in aquatic ecosystems (Tokeshi 1995, Dibble and Harrel 1997), there is a dearth of information in literature concerning species-specific secondary production and life cycles. Secondary production is an important measure for population-level studies because it combines individual growth and population survivorship into a single value (Benke 1984). Analysis of secondary production can contribute to a better understanding of population dynamics and be useful in testing ecological hypotheses (Benke 1993). It can also be an important tool for natural resource administrators in making rational management decisions (Waters 1977).

Chironomus major (Wuelker and Butler 1983) is a large chironomid species distributed in lakes and reservoirs of southeastern United States and recorded from Georgia, Oklahoma, Kentucky, Tennessee, and Alabama. In Kentucky Lake, the conspicuous red larvae are generally found in silty clays with < 1% organic carbon and in association with populations of the mayfly *Hexagenia limbata* and the fingernail clam *Sphaerium striatinum* (Moyer 2002). Morphology and karyosystematics of *C. major* larvae were detailed by Wuelker and Butler (1983) who also named the species based on larval characters. Adults, however, were unknown to Wuelker and Butler (1983) and have not been described. The name *Chironomus major* has since been found to be a junior homonym, and this species will be renamed and the adults described in a separate paper.

The objectives of this study were to describe the life cycle of *C. major* in Kentucky Lake and to estimate the standing stock biomass, secondary production, and the production: biomass ratio.

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METHODS

Study Site and Sampling

Kentucky Lake, created in 1944 by the construction of Kentucky Dam, is located in southwestern Kentucky and northwestern Tennessee (Fig. 1). Kentucky Lake is the farthest downstream of more than 50 reservoirs on the Tennessee River system that were created by the Tennessee Valley Authority. It is the largest reservoir in the eastern United States (296 km long) with 3,830 km of shoreline and 64,750 ha of surface water. The Pacer Point study site is located at km 72.5 (mile 45) on the Tennessee River (Fig. 1). Past surveys (e.g. Moyer 2002) have shown this site (8-10 m depth) to consistently contain the greatest densities *C. major* larvae in this portion of Kentucky Lake. Nutrient and particulate organic carbon patterns of Kentucky Lake have been detailed by Yurista et al. (2001, 2004). Although Kentucky Lake is highly productive (>1400 mg C/m²/day, Taylor 1971), organic matter in surficial sediments is very low ($<1\%$ Yurista et al. 2001). Because of the relatively short mean water residence time (21 days), Kentucky Lake does not stratify thermally, and bottom water oxygen levels rarely are less than 1 mg/L (CRR monitoring data unpublished).

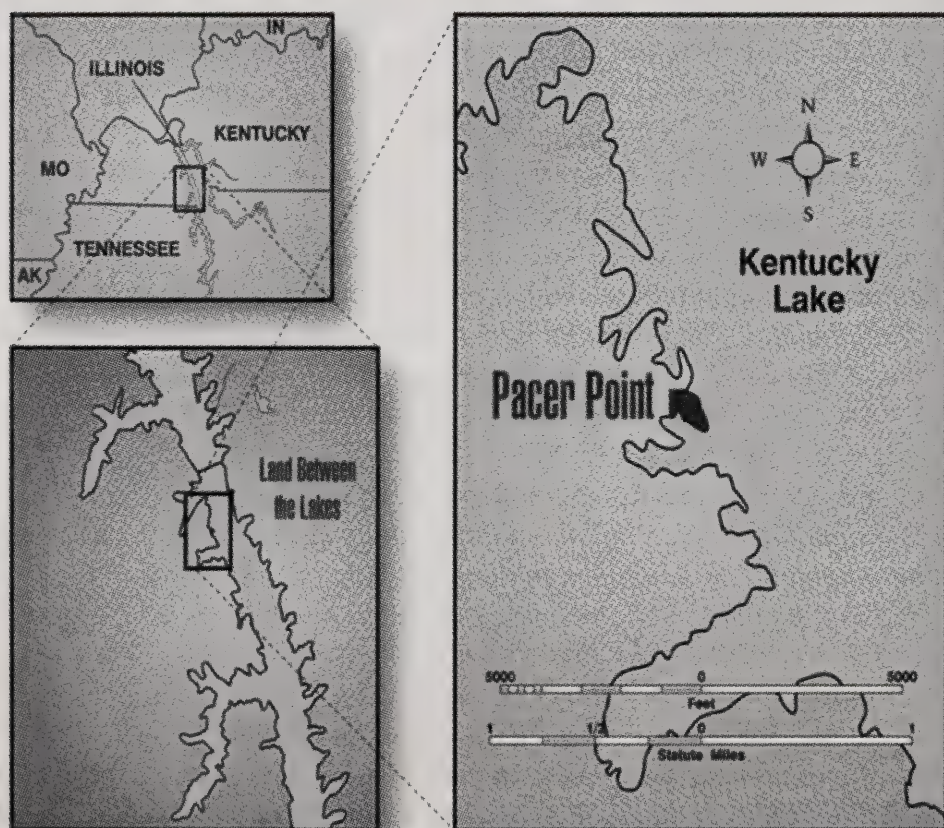


Figure 1. Study area in Kentucky Lake, Kentucky, USA. Lake samples were collected offshore from Pacer Point.

Sampling was initiated in October 2002, and sediment samples were collected using a PONAR grab sampler (sampling area: 522 cm²). PONAR grab samples (30-35) were taken at an approximate depth of 3 m and sieved through a 0.5 mm sieve bucket on each sampling date to collect the chironomid larvae. Chironomid larvae were sorted by morphotypes in the laboratory and mounted in CMC for identification. Head capsule widths were measured with an image analyzer (Motic Images Plus, Hong Kong) attached to a dissecting microscope. Data were organized by number of individuals in each size class on each sampling date, and histograms of size classes over time were constructed. Adult emergence was monitored along the shoreline using UV light traps and sweep nets during the sampling period. Hourly surface water temperature was measured with a data logger (Onset Computer Corporation) from October 2002 to July 2003 (Fig. 2).

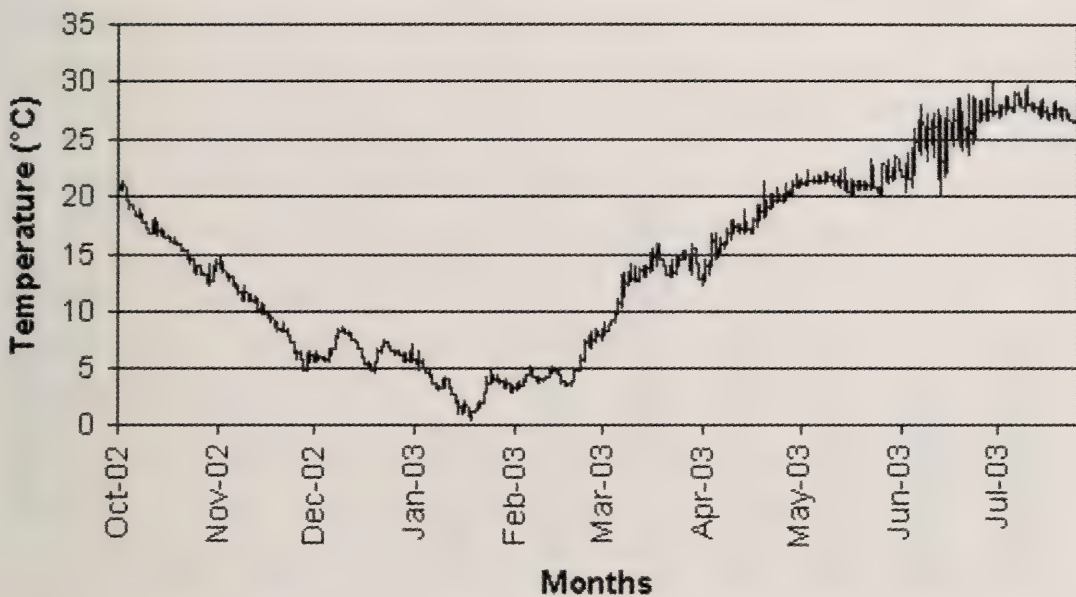


Figure 2. Surface water temperature (°C) measured approximately 10 me offshore in Kentucky Lake from October 2002-July 2003.

Eggs and Larvae Rearings

Adults caught with nets in the field were brought back to the laboratory and put into containers to force mating (Batac-Catalan and White 1982). Seven egg masses were collected and reared in the laboratory to determine cohort length at 3 different temperatures (15°, 20°, and 25 °C) with a photoperiod of 12L:12D. After egg hatching, first instars were transferred to mesh-covered (mesh size: 1 mm) plastic containers (12 cm x 17 cm) containing lake sediment and 500 mL of filtered lake water. Water was gently aerated with air stones. Larvae were fed 1 mL of Tetramin (Tetra,) fish food (Menzie 1981) solution every other day.

Biomass and Secondary Production

Biomass (mg dry mass) of each instar of *C. major* was estimated using fresh larvae dried at 60°C for 48 h. First instar larvae used were laboratory reared. All other larvae were field collected. Live larvae of all 4 instars ($n = 40$) were dried and weighed (± 0.001 mg) on an AD-4 autobalance (Perkin Elmer). First instars were dried in groups of 4-5 individuals and a mean dry mass was calculated. Data for head capsule width in millimeters and dry mass in milligrams were transformed using natural log. A dry biomass conversion was derived from a simple linear regression of log head capsule width on log dry mass (SAS 2001). These data were used to create head capsule width-dry mass regression equation, which then was used to estimate the biomass of field-collected larvae (Benke 1984).

Estimates of *C. major* standing stock biomass, secondary production and production: biomass ratio for the sampling period was determined from head capsule measurements of field preserved specimens. Standing stock biomass was calculated as the amount of biomass present at a point in time (Benke 1984). Secondary production was determined as the living organic matter, or biomass, produced by the population during an interval of time (Benke 1984). Secondary production was estimated using the size frequency method described by Hynes (1961) and Hynes and Coleman (1968), as modified by Hamilton (1969) and Benke (1979). Negative production values for the smallest size classes were set to zero as suggested by Benke and Wallace (1980). The cohort production interval, required to calculate secondary production, was estimated from instar frequency distributions of field-collected specimens, combined with laboratory rearing data. The cohort production interval was defined as the length of time from hatching to the maximum size of final size class (Benke 1979). For practical purposes, the cohort production interval was assumed to be only the larval cycle because the amount of time spent in pupal, terrestrial adult, or egg stages for chironomids is short and irrelevant to aquatic production (Benke 1979). The multiplication of the production of an average cohort by 365/cohort production interval was used to estimate secondary production. The production/biomass, production divided by the mean biomass, approximated the rate of biomass turnover (Benke 1984).

RESULTS

A total of 6 species of chironomid, 4 Chironominae and 2 Tanypodinae were collected at the site (Table 1). Of these, *C. major* comprised 55% of all chironomid specimens collected in the sediment. No first instar larvae were collected most likely because we used a 0.5 mm sieve mesh size. Only fourth instars of *C. major* were collected during October, which corresponded with the adult emergence period. Second instar larvae appeared in early November, and growth occurred throughout the winter. A maximum density of 196 larvae per m² occurred in March (Fig. 3).

Table 1. Chironomid taxa and percent composition (%) in Kentucky Lake at the Pacer Point site for all samples from October 2002 – July 2003.

Taxon	Taxon Composition (% total number)
Subfamily Chironominae	
<i>Chironomus major</i> Wuelker and Butler 1983	55
<i>Chironomus decorus</i> Johannsen 1905	12
<i>Chironomus crassicaudatus</i> Malloch 1915	<1
<i>Cryptochironomus</i> sp.	<1
Subfamily Tanypodinae	
<i>Coelotanypus tricolor</i> Loew 1861	30
<i>Ablabesmyia</i> sp.	2

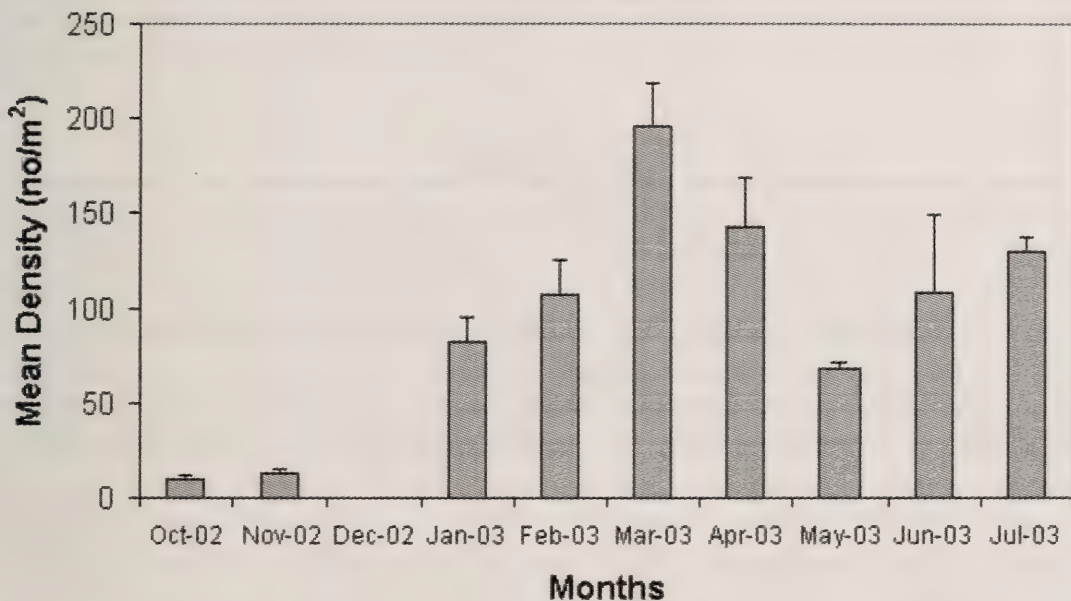


Figure 3. Mean densities (number/m² of bottom substrate) of *Chironomus major* in Kentucky Lake offshore from Pacer Point from October 2002 to July 2003.

Mean head capsule width ranged from 0.13 mm (first instar) to 1.03 mm (fourth instar), and mean dry weight values ranged from 0.002 mg (first instar) to 6.20 mg (fourth instar) (Table 2). Dry mass values for field-preserved specimens were derived from the following significant ($r^2 = 0.96$, $p = 0.001$) simple regression of log head capsule width (in millimeters) vs. log dry mass (in milligrams) for live larvae ($n = 40$): $\log \text{ dry mass} = 0.788 + 3.719 (\log \text{ head capsule width})$.

Production of *C. major* was estimated to be 1.5 g dry mass/m² (Table 3) based on the present study. Mean standing stock biomass was estimated to be 442 mg dry mass/m². The production/biomass rate was calculated to be 3.4 for this population. Size frequency distribution showed *C. major* to be univoltine with adults emerging in October and early November (Fig. 4). Under laboratory conditions that approximated lake temperatures (20 °C), eggs took 3-4 days to hatch. The further development of laboratory reared larval instars varied dependent on temperature. The second instar stage was completed in 45 days at 15° (n = 2), 32 days at 20° (n = 3) and 32 days at 25 °C (n = 2). It took 122 days at 15° and 97 days at 20 °C to complete the third instar stage whereas all third instars died at 25 °C. Fourth instar larvae died at 20° and 25 °C but were still alive at 15 °C after 303 days.

Table 2. Mean head capsule width and dry mass measurements of *C. major* (n=40 for each instar).

Instar	Mean Head Capsule Capsule Width, mm	Mean Dry Mass, mg
1	0.13	0.002
2	0.55	0.76
3	0.78	2.98
4	1.03	6.20

Table 3. Production calculations for *Chironomus major* in Kentucky Lake, October 2002-July 2003, P = production, B = biomass.

Instar	n, no/m ^{2a}	DM, mg ^b	B, mg ^c	△ in n ^d	DM at Loss ^e	DM Loss ^f	x4, mg ^g
1	0	0.002	0				
2	6	0.76	4.56	-6	0.38	-2.3	-9.17*
3	22	2.98	65.56	-16	1.87	-29.9	-119.7*
4	60	6.2	372	-38	4.59	-174.4	-697.7*
				60	6.2	372	1488
Totals			442.12				1488
P= 1488 mg/m ²				B= 442 mg dry mass/ m ²		P/B= 3.4	

* Negative values set to zero.
^a Mean instar number present per square meter.
^b Mean dry mass (in milligrams) of individuals of each instar.
^c Total mean annual biomass for each instar.
^d Change in number of individuals present between stadia.
^e Mean dry mass of individuals of each instar when lost from the population (calculated as DM^x + DM^{x+1} / 2)
^f Total dry mass (milligrams) lost with each instar.
^g Dry mass loss × the number of instars gives mean annual production for each instar.

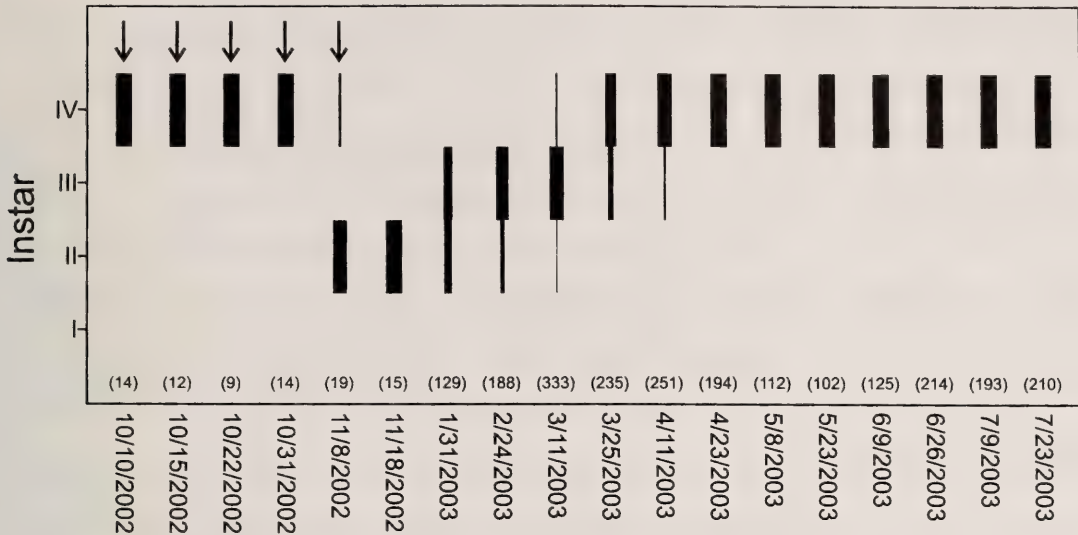


Figure 4. Seasonal distribution and relative frequency for *Chironomus major* instars by date at the Pacer Point site in Kentucky Lake, KY, 2002-2003. Arrows indicate the peak adult emergence. Total numbers of individuals per date are given in parentheses. First instar larvae were not collected.

DISCUSSION

Tokeshi (1995) reviewed the literature on chironomid production from both lentic and lotic systems and suggested that production values less than 2 g dry mass/m²/yr as low productivity (oligotrophy). Secondary production of *C. major* for ten months falls into this category. Frank (1982) reported that secondary production for a smaller chironomid, *Chironomus plumosus*, amounted to 6.81-11.01 g dry mass/m²/yr in the years of 1973 to 1976 in an eutrophic lake (Lake Federsee/South-West Germany). Benson et al. (1980) estimated a production value of 6.0 g dry mass/m²/yr for *C. decorus* in a small pond (Texas), which was higher than our estimates for *C. major*. On the other hand, Tokeshi (1995) reported that, in the case of the genus *Chironomus*, 25% of estimated production values (n=28) were over 10 g dry mass/m²/yr and 71% were over 1 g dry mass/m²/yr. The relatively low productivity of *C. major* could be attributed to several factors. The low densities of *C. major* do not contribute much to the total benthic production of Kentucky Lake. Moyer (2002) also reported low densities of macroinvertebrates collected from two Kentucky Lake embayments. The highest density of chironomids was reported as 406 larvae/m² in Ledbetter Embayment (TRM 42.5) (Moyer, 2002), of which the density is similar to that reported for most large natural lakes, but the diversity is comparatively low (Winnell and White 1985). The low densities of *C. major* and other chironomids in the main lake are probably not related to overlying water conditions but could result from low carbon (food) availability in the sediments. Although the water column is highly productive, much of the production appears to be flushed from the lake before reaching the bottom (Yurista et al., 2001).

Chironomus major larvae are present throughout the year and overwinter as second and third instar larvae. Size frequency distribution appears to be univoltine with single adult emergence in the fall. While spring/summer emergence is observed most commonly among univoltine species (Dendy 1971; Lindegaard 1992), there are examples of univoltine species emerging in fall. In Lake Kasumigaura, Japan, the large and abundant *Tokunagayusurika akamusi* emerges between late October and early December, the main emergence taking place in early November (Iwakuma 1986). Emergence in univoltine species is often short duration, lasting no more than one month with an intensive emergence occurring within a period of 1-2 weeks (Tokeshi 1995). We observed a similar pattern in *C. major* that lasted for 5 weeks with peak adult emergence during the first two weeks of October.

Production (P) to mean biomass (B) ratios expresses the rates of biomass turnover and has been frequently quoted as an important measure of productivity (Tokeshi 1995). Tokeshi (1995) reported that in the subfamily Chironominae there appear to exist two weak modes in the frequency distribution of P/B ratios, one between 1 and 3 and the other between 5 and 7, the latter mostly encompassing multivoltine species. Large species with relatively long larval life such as *Chironomus* spp. tend to have low P/B values (Tokeshi 1995). The P/B ratio of *Chironomus plumosus* was estimated to be 1.6 in Alderfen Broad, U.K (Mason 1977) and 2.4 in Lake Beloie, Russia (Borutski et al., 1971), whereas Benson et al. (1980) estimated the P/B ratio of 19.6 for a multivoltine *Chironomus decorus* in a shallow pond, TX. In this study, P/B ratio (3) for *C. major* is very similar to those reported for large univoltine chironomid species.

In summary species-specific secondary production and life cycle information is important in trophic dynamics of aquatic systems. The present study provided baseline information on an ecologically significant invertebrate in the Kentucky Lake benthic environment. Ongoing monitoring will add additional data to estimate the production for the full year.

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SCIENTIFIC NOTE

**THE RED IMPORTED FIRE ANT IS NOW IN MEXICO:
DOCUMENTATION OF ITS WIDE DISTRIBUTION
ALONG THE TEXAS-MEXICO BORDER¹****Sergio R. Sánchez-Peña,^{2,3} Richard J. W. Patrock,³ and Lawrence A. Gilbert³**

Over the last decade, the red imported fire ant, *Solenopsis invicta* Buren has proven itself a cosmopolitan pest. Confined to central South America until its invasion of the United States around 1930, this species has since tramped its way around the Caribbean from Puerto Rico to Trinidad (Davis et al., 2001) and is now well ensconced along the Western Pacific rim in Brisbane, Australia (Moloney and Vanderwoude 2002), Malaysia (Na and Lee 2001), Taiwan (Yu-Tzu 2004), Hong Kong, Macao and the Guandong Province of southern China (Anon. 2005). Despite this globetrotting, *S. invicta* had failed to cross from Texas into Mexico across the slender Rio Grande since it was first found in counties bordering the river in 1991 (Allen et al., 1993). Here we report our finding of populations that have made the jump across the Rio Grande into Mexico. In 2001, one of us (RJWP) found *S. invicta* within meters of the Rio Grande in the southmost area of Brownsville, Texas. In 2004, S. R. Sánchez-Peña surveyed Mexican sites that spanned from the Colombia, Nuevo León (NL) border crossing point to the Playa Bagdad beach (Tamaulipas) on the Gulf of Mexico. Samples were also taken along major highways running south from the border to Monterrey, NL. Urban areas and towns searched included Colombia, Monterrey, Guadalupe, Cadereyta, General Bravo, the Sabinas Hidalgo toll road station, Cerralvo and General Treviño; all in NL; and Nuevo Laredo, Ciudad Mier, Miguel Alemán, Diaz Ordaz, Valadecies, Reynosa, Rio Bravo, Empalme, and Matamoros; all in Tamaulipas. Additional points were searched in between these towns. All points are in two vegetational areas: the South Texas or Rio Grande Plains and the Gulf prairies and marshes; the first is part of the Tamaulipan Biotic Province. Average annual rainfall ranges from 43 to 76 cm, increasing from West to East (Everitt and Drawe 1993). The proportion of Neotropical elements in the vegetation increases rapidly to the South, especially near the coast. Fire ants in general and *S. invicta* in particular are markedly anthropophilic, and readily invade moist, disturbed areas. Therefore, searches were directed towards the preferred habitats colonized by *S. invicta*: managed and artificial pastureland, watering holes, landscaped areas, squares (plazas) and gardens, parks, sidewalks, nurs-

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eries, greenhouses, junk yards, parking lots, edges of agricultural fields, road sides, restaurants, clearings in general, and flooded areas.

More than 800 *Solenopsis* samples were collected across the surveyed area. We made directed searches and baiting. Baits (pieces of oil-canned tuna or hot-dog) were placed on foraging grounds of *Solenopsis* spp., attracting tens of foragers of different sizes. When aboveground nests (mounds) were observed, we also collected workers by disturbing those mounds, causing workers to rush out aggressively. Sexualls were collected when present from these nests. Queens (wingless foundresses) were also collected on the ground after mating flights. Ants were preserved in 96% ethanol.

Most samples correspond to non-*S. invicta* fire ants. The only places where *S. invicta* was detected are as follows: SRSP collected this pest in four points in Tamaulipas, one colony in the vicinity of the Nuevo Laredo International Crossing II (N 27° 29' 46.4", W 99° 29' 36.0") and at three locations in Matamoros. Of these, two collections were determined from single colonies (N 25° 53' 40.5", W 097° 29' 51.9") and (N 25° 52' 24.9", W 097° 28' 19.6"), and a third was an infestation of about two hectares (N 25° 52' 09.2", W 097° 24' 24.4", and N 25° 51' 34.7", W 097° 24' 33.6") across from the southernmost area of Brownsville (Fig. 1). An additional population about 500 km NW was found by a collaborator in Ciudad Acuña, Coahuila, across the border from Del Rio, Texas, in February 2005. Voucher specimens are kept at the Entomology Collections of Brackenridge Field Laboratory, University of Texas at Austin and the Universidad Autónoma Agraria Antonio Narro, in Saltillo.

Solenopsis invicta does not appear to be ubiquitous on this section of the Mexican side of the border. Phillips and Thorvilson (1993) hypothesized that the most likely window for invasion of this pest into Mexico would be through Tamaulipas because of this area's extensive irrigated agriculture. Once in Mexico, they envisioned that *S. invicta* would be able to propagate along the Gulf coast before its populations spread to more mesic, central sections of the country. This path of range extension has been theoretically validated in a model by Morrison et al. (2004), in a work that suggests this route might be the only one available to imported fire ants for unaided movement into much of Mexico. Now that *S. invicta* has made the first step, we suggest it is important to implement eradication procedures of these small-localized populations; the longer this ant resides in Mexico the higher the chance of human-aided transport to the interior. We therefore encourage more extensive monitoring of the most likely zones of invasion and considering steps that will reduce the likelihood of accidental transport of *S. invicta* further south. Care should be taken not to disrupt native ant populations and the resistance they provide in stemming *S. invicta* establishment (Rao and Vinson 2004).



Fig. 1. Main collecting sites for *Solenopsis* spp. in northeastern Mexico. Sites where *Solenopsis invicta* was collected are marked with a circle **●**. All sites are located in Mexico. Locality 4, El Cielo Biosphere Reserve, is noted for its notoriously high biodiversity. Key to locations: 1 Cerralvo, 2 Ciudad Acuña, 3 Colombia, 4 El Cielo Biosphere Reserve, 5 G. Bravo, 6 Matamoros, 7 Miguel Alemán, 8 Monterrey, 9 Nuevo Laredo, 10 Reynosa, 11 Rio Bravo. Abbreviation of the Mexican states follows: Coahuila (CA), Nuevo León (NL), and Tamaulipas (TM). Texas (U.S.A.) is abbreviated TX. The map was drawn using ArcView.

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SCIENTIFIC NOTE

A COLLECTION OF *POECILOCRYPTICUS FORMICOPHILUS* GEBIEN (COLEOPTERA: TENEBRIONIDAE) FROM A MOUND OF THE IMPORTED FIRE ANT HYBRID, *SOLENOPSIS INVICTA* X *RICHTERI* (HYMENOPTERA: FORMICIDAE) FROM MISSISSIPPI, U.S.A.¹

Joe A. MacGown²

Poecilocrypticus formicophilus Gebien is a small, colorful tenebrionid beetle native to the Atlantic coast of South America. Steiner (1982) reported this species from Russell Co., Alabama (3 specimens), Leon Co., Florida (1 specimen), and Hancock Co., Mississippi (1 specimen). Steiner speculated that *P. formicophilus* was a recent introduction to the southeastern United States and apparently was established in that region. He also stated that this beetle might be associated with the imported fire ant, *Solenopsis richteri* Forel. This speculation is based primarily on a single specimen of *P. formicophilus* collected during a survey of animals associated with fire ants done in Uruguay by Silviera-Guido et al. (1972). It is not certain whether the specimen from that survey was actually in a fire ant mound or was only in the vicinity of one, because it was labeled somewhat ambiguously as "*saevissima richteri* nest" (referring to *Solenopsis richteri*). Fragments of a beetle that appeared to be *P. formicophilus* were recovered from a nest in Bastrop County, Texas (Taber, 2000). It is not known whether the beetle was prey of the fire ants, or was living in the nest as a myrmecophile. All of the published records of *P. formicophilus* in the United States coincide with areas where either *S. richteri* or another exotic fire ant species, *S. invicta* Buren, have become established. Recent collections of this beetle also fall within the geographic range of imported fire ants, with records in Mississippi from Greene Co. (1 specimen), Hancock Co. (3 specimens), and Jackson Co. (4 specimens) and in Alabama from Baldwin Co. (3 specimens). *Poecilocrypticus formicophilus* has also been collected from numerous other localities in other states where imported fire ants have spread (records from other states to be published at a later date, W. E. Steiner, Pers. Comm.) apparently paralleling the imported fire ant movement in the United States. However, no live specimens of *P. formicophilus* have been reported as being found in any *Solenopsis* spp. nests in the United States.

On 4 August 2002, I collected a single live specimen of *P. formicophilus* in an active mound of the hybrid fire ant, *S. invicta* X *richteri*. The mound was at the base of *Pinus taeda* Linnaeus (Pinaceae) located in a remnant of the Black Belt Prairie in Sessums, Oktibbeha County, Mississippi. This is the first definitive record of *P. formicophilus* being found alive in a fire ant mound in the United States, thus supporting Steiner's supposition that this beetle is associated with fire ants.

MacGown and JoVonn G. Hill collected seven individuals of *P. formicophilus* at Jeff Davis Lake in Jefferson Davis County on 11 August 2005. The beetles were col-

¹ Received on April 26, 2005. Accepted on June 10, 2005.

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lected in grass clippings at the base of *Quercus falcata* Michaux (Fagaceae) in a disturbed open parklike area near a lake. Several species of ants were present in the sample with the beetles including *Brachymyrmex musculus* Forel, *Hypoponera opaciceps* (Mayr), *Pyramica membranifera* (Emery), *Pyramica* sp., *Cyphomyrmex rimosus* (Spinola), and *Solenopsis invicta* Buren. On a subsequent trip to the same site by Hill on 18 September 2005, live individuals of *P. formicophilus* were observed in the nests of *B. musculus*, *C. rimosus*, and *S. invicta*. All three of these ant species are considered to be exotic ants to this country from South and Central America. The presence of this beetle in the nests of two other species of ants indicates that it is not restricted to imported fire ant nests.

It is not clear whether *P. formicophilus* is an occasional nest scavenger or a more specialized myrmecophile. Other collections of this beetle have been made using a variety of methods, such as Berlese litter samples, pitfall traps, and blacklight traps, but not from inside fire ant mounds. In a study of arthropods found in imported fire ant (*S. richteri*) mounds done by Collins and Markin (1971), fifty-two species of arthropods were collected, but *P. formicophilus* was not found. Similarly, a study of beetles in fire ant nests in Texas done by Summerlin (1978) did not yield this species. However, those studies may have predated the arrival of *P. formicophilus* in those states. Except for some pupal characters (Steiner 1995), the biology and immature stages of this species remain unknown.

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BOOK REVIEW

A COUNTRYWOMAN'S JOURNAL. THE SKETCHBOOKS OF A PASSIONATE NATURALIST. 2002 by Margaret Shaw with an introduction by Peggy Vance. Constable & Robinson Ltd. London, England, United Kingdom. 144 pp. ISBN: 1-84119-632-2. Hardbound.

Recently, a friend returned from southern England and brought me a present: Margaret Shaw's *A countrywoman's journal, The sketchbooks of a passionate naturalist*. "Hidden in a drawer for over seventy years, Margaret [Grace] Shaw's [MGS] perfectly preserved sketchbook journal of 1926 to 1928 record in watercolor and prose the flora and fauna of an almost vanished world" (inside front cover). An earlier journal is known for 1902 (p. 11).

Margaret was born in 1886 to a well-to-do British family favored by the increased industrialization. The Shaws were able to travel abroad to continental Europe frequently, where cities still harbored contrasts deplored by earlier social reformers: the wealthy and prosperous living alongside masses swarming in pauperism. However, those social contrasts are not obvious in *A countrywoman's journal*.

Shaw's upbringing appears to have included the prescribed recipe for Victorian English young women of the time: the arts, literature, and a healthy dose of activities meant to foster an air of refinement. Her journal entries include brief remarks on insects and birds, which she often addresses as "he," as well as plants, mammals, mollusks, and other natural history objects, water colored to such detail that one can recognize families and even genera. MGS describes trees, parks, days, sunsets, and many others as "lovely," as commonly heard in the United Kingdom.

Many insects are featured in her vignettes including, dragonflies (Odonata: Anisoptera), earwigs (Dermaptera), Common English Meadow Grasshoppers (Orthoptera), water skaters (Hemiptera: Gerridae), lacewings (Neuroptera), ladybird beetles (Coleoptera: Coccinellidae, 2-spotted and 7-spotted *Coccinella septempunctata*), tiny beetles crawling on tulip bulbs, blue bottle flies (Calliphoridae), mosquitoes or common gnats, caddisfly larvae (Trichoptera), "humbe bees" (bumble bees, Apidae), queen wasps (Vespidae), "oak apples" (probably Cynipidae) and above all, lepidopterans, lots of them, such as Peacocks (*Inachis* sp.) and Red Admirals (*Vanessa* sp., both Nymphalidae), Brimstones (*Gonepteryx* sp., Pieridae), "white ermine moth" (Arctiidae), "herald moths" (Noctuidae), and many others. On occasions, Shaw gives considerable biological information on some insects. For instance, about the ladybird beetles she says "it is a most useful insect as it lives on the plant-lice that blight roses and hops" (April 21, 1927). Of water skaters, she writes "have three pairs of legs, the first pair just below the head the second at the lower end of the chest. These are their oars – the last pair set entirely as rudders and are never used for swimming" (April 22, 2005).

MGS also knew plants in detail (May 30, 1927) and her illustrations are often sufficient to recognize families and genera (e.g. Greater Stitchwort, *Stella holostea*, Caryophyllaceae, 27 April 1927). On her way from Bordeaux to St. Jean de Luis, she "passed through miles of pines forests, nearly every tree being tapped for its turpentine" (June 7, 1928), a remark that warmed my heart as I collect plant exudates (resins, gums, gum resins, latexes, kinos, and others) for research.

This facsimile of her journal is also spiced with poetic language, such as "the frost sparkled like tiny diamonds on leaves and grass" (December 16, 1926) or about a group of toad eggs "the spawn is a jelly substance looking like masses of transparent boiled tapioca" (March 3, 1927). Personifications, particularly with respect to animal behavior abound such as, "I hope the parents got them [the blackbird "babies"] safely away (April 30, 1927) are reminiscent of Jean-Henri Fabre [*Entomological News* 114(5):288]. Shaw's images of rabbits resemble those of Beatrix Potter's Peter Rabbit).

As one reads Shaw's accounts, one wonders what happened to MGS on May 1, 2, and 8, 1927, as there seem to be empty spaces for water colors that were never produced or why her second journal (1 January to 31 December 1928) has less drawings and her writing is more densely packed onto each page. My friend remembered her trip to southern England fondly when she read "This is a great sheep farming district and it is lambing time (March 20, 1927). "[A]s the Old Year died" (December 31, 1928), one ponders about the passage of time and what others were doing when these journal entries were written.

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SOCIETY MEETING OF MARCH 23, 2005

Population Genetics of Introduced Disease Vectors

Dina M. Fonseca, Ph.D., Assistant Curator
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Dr. Fonseca's presentation focused on mosquitos (Diptera, Culicidae) as introduced disease vectors to both the Hawaiian Islands and the continental United States. Hawaii had no mosquitoes prior to the introduction of *Culex quinquefasciatus*. Because native Hawaiian birds, such as the Hawaiian honeycreepers, are uniquely susceptible to malaria and bird pox, both transmitted by this mosquito, the introduction of *Cx. quinquefasciatus* has contributed to their decline. According to Dr. Fonseca, there have been two separate introductions of this species, one from the Americas in the 1980s and the second from the south Pacific. This finding explains both a reported change in elevational distribution of *Cx. quinquefasciatus* and the timing of the impact of avian malaria on local bird populations. There are now eight introduced species of mosquito in the Hawaiian Islands although only *Cx. quinquefasciatus* transmits the avian diseases.

The continental U.S.A. also has eight introduced species of mosquito, several mirroring those in Hawaii. Of interest to Dr. Fonseca and her research group is the genetics, distribution, and behavior of the *Culex pipiens* complex, a group of very closely related mosquitoes that include *Cx. quinquefasciatus* and *Cx. pipiens*, the latter, one of the principal vectors of West Nile virus (WNV). Historically, taxonomic traits (e.g. male genitalia) and behavioral strategies (e.g. the necessity, or absence of a blood meal for egg laying), and blood host preferences, have been used to separate species, subspecies, and forms in the *Cx. pipiens* complex. The existence of hybrids and the difficulty of assessing behavior and physiology have led Dr. Fonseca to develop diagnostic tools using genetic markers.

Employing multilocus genotype analysis, a genetic tool using fast mutating microsatellite loci to provide a DNA fingerprint of each species, Dr. Fonseca's lab has fine-tuned distributional data on the two common mosquitoes of the *Cx. pipiens* complex. In the eastern United States, *Cx. pipiens* occurs at northern latitudes and *Cx. quinquefasciatus* at southern latitudes. Genetic sampling of eastern and western populations showed that the introgression between the two species is more complex than thought, with the hybrid zone being more extensive than expected and virtually all specimens being hybrids in the midlatitudes. In addition, analyses of microsatellite loci yield differentiation between epidemiologically divergent "forms" of *Cx. pipiens* - *Cx. pipiens* form *pipiens* can be separated from *Cx. pipiens* form *molestus* using genetic markers.

In conclusion, Dr. Fonseca underscored how the study of the population genetics of disease vectors allows assessment of intra- and interspecific variability and unravels the evolution of complex systems. The information obtained by using molecular markers generates testable hypotheses regarding species adaptation, habitat expansion, hybridization, and ecology. She hopes to develop "genetic counseling" to vector control programs by using genetic assays to predict epidemiological differences between populations.

In observations made by members at the meeting, Jack Gingrich noted that wolf spiders, an unusual moth, and bats were encountered in an underground bunker at Fort Delaware (Pea Patch Island, in the middle of the Delaware River, just above the entrance to the Delaware Bay), and a species of *Calosoma* Fiery Searcher (Carabidae) was seen by another attendee. There were 28 people present for the meeting.

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Jorge A. Santiago-Blay¹

During the time I have served as editor of *Entomological News* [Volumes 114 (2003) to 116 (2005)], over 200 post-submission reviewers from all continents, except Antarctica, have generously donated their time and energy. Herein, I wish to gratefully acknowledge those who contributed towards the completion of volume 116 and those who served in previous volumes whom I inadvertently overlooked to acknowledge [the latter with a parenthetical notation (“volume #”), where the # indicates the volume to which they contributed]. The names of all reviewers are arranged alphabetically by last name; affiliations or addresses follow. I also acknowledge those reviewers who prefer to remain anonymous.

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A collection of *Poecilcrypticus formicophilus* Gebien (Coleoptera: Tenebrionidae) from a mound of the Imported Fire Ant hybrid, *Solenopsis invicta* X *richteri* (Hymenoptera: Formicidae) from Mississippi, U.S.A. Joe A. MacGown 367

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Magicicada sp. cicada. Photograph taken by John Zyla (J.F. Taylor, Inc., Lexington Park, Maryland, U.S.A.). For more details, see Edwards et al., page 273.

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